

APTD-0812

PB 207 747

**CHARLOTTE METROPOLITAN AREA
AIR POLLUTANT EMISSION INVENTORY**

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service

BIBLIOGRAPHIC DATA SHEET		1. Report No. APTD-0812	2.	3. Recipient's Accession No.																			
4. Title and Subtitle Charlotte Metropolitan Area Air Pollutant Emission Inventory				5. Report Date May 1970																			
7. Author(s) Michael J. McGraw				6.																			
9. Performing Organization Name and Address U. S. Department of Health, Education, and Welfare National Air Pollution Control Administration Division of Air Quality and Emission Data Durham, North Carolina				8. Performing Organization Rept. No.																			
12. Sponsoring Organization Name and Address Same <i>in North and South Carolina</i>				10. Project/Task/Work Unit No.																			
				11. Contract/Grant No.																			
				13. Type of Report & Period Covered																			
				14.																			
15. Supplementary Notes																							
16. Abstracts A summary report is presented of the emission inventory for the Charlotte Metropolitan Area. The report provides estimates of the present levels of air pollutant emissions and status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides, are delineated with respect to source type, season of the year, and geographical distribution within the area. The Study Area which was chosen on the basis of the distribution of population and air pollution sources, consists of twelve counties surrounding Charlotte. A grid coordinate system was used to show the geographical distribution of emissions within counties. All sources of emissions were classified into five categories: transportation, stationary fuel combustion, solid-waste disposal, industrial processes, and evaporative losses.																							
17. Key Words and Document Analysis. 17a. Descriptors <table border="0"> <tr> <td>Air pollution</td> <td>Sources</td> </tr> <tr> <td>Emission</td> <td>Fuel</td> </tr> <tr> <td>Inventories</td> <td>Combustion</td> </tr> <tr> <td>Sulfur oxides</td> <td>Transportation</td> </tr> <tr> <td>Nitrogen oxides</td> <td>Waste disposal</td> </tr> <tr> <td>Hydrocarbons</td> <td>Industrial plants</td> </tr> <tr> <td>Carbon monoxide</td> <td>Evaporation</td> </tr> <tr> <td>Particles</td> <td></td> </tr> <tr> <td>Seasonal variation</td> <td></td> </tr> </table>						Air pollution	Sources	Emission	Fuel	Inventories	Combustion	Sulfur oxides	Transportation	Nitrogen oxides	Waste disposal	Hydrocarbons	Industrial plants	Carbon monoxide	Evaporation	Particles		Seasonal variation	
Air pollution	Sources																						
Emission	Fuel																						
Inventories	Combustion																						
Sulfur oxides	Transportation																						
Nitrogen oxides	Waste disposal																						
Hydrocarbons	Industrial plants																						
Carbon monoxide	Evaporation																						
Particles																							
Seasonal variation																							
17b. Identifiers/Open-Ended Terms Charlotte, North Carolina North Carolina South Carolina Particulates Stationary sources																							
17c. COSATI Field/Group 13B																							
18. Availability Statement Unlimited		19. Security Class (This Report) UNCLASSIFIED		21. No. of Pages 79																			
		20. Security Class (This Page) UNCLASSIFIED		22. Price																			

CHARLOTTE METROPOLITAN AREA AIR POLLUTANT
EMISSION INVENTORY

Prepared by
Michael J. McGraw

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Environmental Health Service
National Air Pollution Control Administration
Division of Air Quality and Emission Data
Durham, North Carolina
May 1970

ACKNOWLEDGMENTS

Sincere gratitude is extended by the National Air Pollution Control Administration to the many individuals and companies who contributed to this study.

Special thanks are due to William Dentler, Harold Cable and John Gibson of the Mecklenburg County Health Department; W. E. Knight and James McColman of the State of North Carolina Department of Water and Air Resources; E. M. Fenn of the Catawba-Lincoln Air Pollution Control Unit; James Spears of the Cleveland County Air Pollution Control Program; Gary Lindler of the Gaston County Health Department; William Heitman of the Rowan County Health Department and Ken Stone and Otto Pearson of the South Carolina Pollution Control Authority, who contributed invaluable assistance in the gathering of data for this report.

PREFACE

This report, which presents the emission inventory for the Charlotte Metropolitan Area, is another in a series of surveys outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These surveys, conducted by the National Inventory of Air Pollutant Emissions and Control Branch of the National Air Pollution Control Administration, provide estimates of the present levels of air pollutant emissions and status of their control. The pollutants which include sulfur oxides, particulates, carbon monoxide, hydrocarbons and nitrogen oxides, are delineated with respect to source type, season of the year and geographical distribution within the area. The general procedure for the surveys is based upon the rapid survey technique for estimating air pollutant emissions.¹ These reports are intended to serve as aids in the proposing of boundaries of Air Quality Control Regions, as directed by the Air Quality Act of 1967.

TABLE OF CONTENTS

Introduction.....	Page 1
Summary.....	3
Description of Study Area.....	9
Grid Coordinate System.....	16
Emissions by Category.....	18
Stationary Fuel Combustion.....	18
Steam-Electric Utility.....	18
Industrial.....	24
Residential.....	26
Commercial-Institutional.....	28
Transportation.....	28
Motor Vehicles.....	28
Aircraft.....	30
Railroads.....	30
Solid Waste Disposal.....	33
Incineration.....	33
Open Burning.....	35
Industrial Processes.....	35
Evaporative Losses.....	38
Automobiles.....	38
Gasoline Storage and Handling.....	40
Consumption of Solvents.....	40
Emissions by Jurisdiction.....	41
Emissions by Grid.....	54
Contribution of Point and Area Sources.....	55
Emission Densities.....	62
References.....	69
Appendix A.....	70
Appendix B.....	71

LIST OF TABLES

Table		Page
1	Summary of Air Pollutant Emissions in Charlotte Study Area.....	6
1A	Summary of Air Pollutant Emissions in Study Area.....	7
2	Percentage of Contribution of Each Source Category to Total Emissions.....	8
3	Area and Population Characteristics for Study Area.....	12
4	Selected Manufacturing Establishments in Study Area.....	15
5	Annual Consumption of Natural Gas in Study Area.....	19
6	Annual Consumption of Coal in Study Area.....	20
7	Annual Consumption of Residual Fuel Oil in Study Area.....	21
8	Annual Consumption of Distillate Fuel Oil in Study Area....	22
9	Average Chemical Analysis of Fuels Consumed in Study Area...	23
10	Air Pollutant Emissions from the Combustion of Fuels in Stationary Sources.....	25
11	Summary of Domestic Heating by Number of Dwelling Units in Study Area.....	27
12	Vehicle Miles of Travel for Motor Vehicles in Study Area....	29
13	Summary of Air Pollutant Emissions from Transportation Sources.....	31
14	Air Traffic Activity at the Largest Airports in Study Area..	32
15	Solid Waste Balance for Study Area.....	34
16	Air Pollutant Emissions from Solid Waste Disposal.....	36
17	Summary of Air Pollutant Emissions from Industrial Processes	37
18	Hydrocarbon Emissions from Evaporative Loss Sources in Study Area.....	39
19	Summary of Air Pollutant Emissions in Cabarrus County.....	42
20	Summary of Air Pollutant Emissions in Catawba County.....	43
21	Summary of Air Pollutant Emissions in Cleveland County.....	44
22	Summary of Air Pollutant Emissions in Gaston County.....	45
23	Summary of Air Pollutant Emissions in Iredell County.....	46
24	Summary of Air Pollutant Emissions in Lincoln County.....	47

TABLES (cont.)

Table		Page
25	Summary of Air Pollutant Emissions in Mecklenburg County....	48
26	Summary of Air Pollutant Emissions in Rowan County.....	49
27	Summary of Air Pollutant Emissions in Union County.....	50
28	Summary of Air Pollutant Emissions in Chester County.....	51
29	Summary of Air Pollutant Emissions in Lancaster County.....	52
30	Summary of Air Pollutant Emissions in York County.....	53
31	Summary of Air Pollutant Emissions from Point Sources.....	55
32	Summary of Air Pollutant Emissions from All Sources.....	58

LIST OF FIGURES

Figure		Page
1	Map of the Charlotte Study Area and Surrounding Cities.....	10
2	Detailed Map of Charlotte Study Area.....	11
3	Population Density for Charlotte Study Area.....	13
4	Grid Coordinate System for Study Area.....	17
5	Point Source Locations for Study Area.....	63
6	Sulfur Oxide Emission Density from All Sources in Study Area.....	64
7	Particulate Emission Density from All Sources in Study Area.....	65
8	Carbon Monoxide Emission Density from All Sources in Study Area.....	66
9	Hydrocarbon Emission Density from All Sources in Study Area.....	67
10	Nitrogen Oxide Emission Density from All Sources in Study Area.....	68

INTRODUCTION

This report is a summary of the Charlotte air pollutant emission inventory conducted in December 1969. Since all inventories are based upon a calendar year, the data and emission estimates presented are representative of 1968 and should be considered as indicating the conditions as existed during that year.

The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of twelve counties surrounding Charlotte. This area covers approximately 6,000 square miles and had a 1968 population of 1,100,000.

A grid coordinate system was used to show the geographical distribution of emissions within counties. The Study Area was subdivided into 92 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 400 square kilometers in the rural areas.

All sources of emissions were classified into five categories--transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups--point sources and area sources. Facilities, which emit large quantities of air pollutants, were considered individually as point sources, while the many remaining contributors such as motor vehicles, residential and commercial fuel users, small industries and on-site refuse burning equipment, were considered collectively as area sources. For this report, seventy-one individual sources, which had emissions greater than 0.5 tons per average annual day for any pollutant, were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, and control efficiencies and emission factors relating these indicators to emission rates.² These factors represent average emission rates for a particular source category. Since individual sources have inherent differences that cannot always be taken into consideration, discrepancies between

the actual and estimated emissions are more likely in individual sources than in the total emissions for a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, these estimates are of sufficient accuracy and validity in defining the extent and distribution of air pollutant emissions in the Study Area.

SUMMARY

The annual emissions as estimated by the Charlotte Metropolitan Area Air Pollutant Emission Inventory are:

Sulfur Oxides	197,500
Particulates	366,300
Carbon Monoxide	531,300
Hydrocarbons	91,700
Nitrogen Oxides	144,400

The following is a brief description of the air pollutant emissions as presented in Table 1 and Table 2.

Sulfur Oxides: The largest portion of the sulfur oxides emitted came from the five steam-electric plants located in the Study Area which had coal fired units. Together these plants accounted for 86 percent of total sulfur oxides. The combustion of fossil fuels by other stationary sources accounted for 12 percent of the sulfur oxides emitted. The remaining 2 percent was distributed under motor vehicles, refuse disposal and small industries.

Particulates: The majority of the particulate emissions (67%) came from the combustion of coal at the five power plants in the Study Area. Individual sources of particulates from industrial processes accounted for 21 percent of total particulate emissions. The largest sources from industrial processes were plants in the mineral products industry, which accounted for 16 of this 21 percent. The combustion of coal by industrial sources was the only other significant source of particulates, accounting for 8 percent of the total.

Carbon Monoxide:

In most metropolitan areas the largest source of carbon monoxide emissions is from automobiles and other motor vehicles. This was also true in Charlotte as motor vehicles contributed 93 percent of the carbon monoxide emitted annually. Other transportation sources including railroad and aircraft operations contributed another 1 percent.

The only other significant source of carbon monoxide was from the inefficient combustion of refuse at open burning dumps and on-site incinerators. This category accounted for about 3 percent of the total emissions.

Hydrocarbons:

Exhaust gases from motor vehicles was the primary source of hydrocarbon emissions, accounting for over 45 percent of the total. Evaporative losses from motor vehicles which includes losses from the gas tank, carburetor and engine crankcase accounted for 25 percent of total hydrocarbon emissions. Other smaller evaporative loss sources including gasoline storage and handling, industrial solvent usage, dry cleaning plants, and miscellaneous solvent usage, collectively accounted for 20 percent of total emissions. Other sources included the open burning of solid waste, railroad and aircraft operations, and stationary fuel combustion, which accounted for 4, 2 and 2 percent, respectively, of total emissions.

Nitrogen Oxides:

The largest sources of nitrogen oxides were the five steam-electric plants. The combustion of coal at these plants accounted for 62 percent of total nitrogen oxide emissions. The combustion of coal, oil, and gas at other stationary sources accounted for 13 percent of total emissions.

The second largest source of nitrogen oxides was the exhaust gas from motor vehicles, which contributed almost 23 percent of the total. The remaining 2 percent of the nitrogen oxides came from the disposal of refuse by incineration and open burning and from industrial process emissions.

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN STUDY AREA, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	3,000	6,000	492,400	41,100	31,200
Other	300	1,000	7,000	2,300	2,000
Subtotal	3,300	7,000	499,400	43,400	33,200
Stationary Fuel Combustion					
Industry	16,600	29,000	1,100	400	14,900
Steam-Electric	171,900	246,000	2,200	900	90,000
Residential	2,500	900	2,300	500	1,300
Commercial and Institutional	2,500	1,800	1,900	400	1,700
Subtotal	193,500	277,700	7,500	2,200	107,900
Refuse Disposal					
Incineration	200	1,000	4,400	80	300
Open Burning	150	2,300	12,300	4,340	1,600
Subtotal	350	3,300	16,700	4,420	1,900
Industrial Processes	300	78,300	7,700	230	1,400
Evaporative Losses	--	--	--	41,400	--
GRAND TOTAL ^a	197,500	366,300	531,300	91,700	144,400

a = Totals have been rounded.

TABLE 1A SUMMARY OF AIR POLLUTANT EMISSIONS IN STUDY AREA, 1968
(1000 kg/year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	2,720	5,440	446,710	37,290	28,300
Other	270	910	6,350	2,090	1,810
Subtotal	2,990	6,350	453,060	39,380	30,110
Stationary Fuel Combustion					
Industrial	1,560	26,310	1,000	360	13,520
Steam-Electric	155,950	223,170	2,000	820	81,650
Residential	2,270	820	2,090	450	1,180
Commercial and Institutional	2,270	1,630	1,720	360	1,540
Subtotal	162,050	251,930	6,810	1,990	97,890
Refuse Disposal					
Incineration	180	910	3,990	70	270
Open Burning	140	2,090	11,160	3,940	1,450
Subtotal	320	3,000	15,150	4,010	1,720
Industrial Processes	270	71,030	6,990	210	1,270
Evaporative Losses	--	--	--	37,560	--
GRAND TOTAL	165,630	332,310	482,010	83,150	130,990

TABLE 2 PERCENTAGE CONTRIBUTION OF EACH SOURCE CATEGORY TO
TOTAL EMISSIONS IN THE CHARLOTTE STUDY AREA

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	1.5	1.6	92.7	44.8	21.6
Other	0.1	0.3	1.3	2.5	1.3
Subtotal	1.6	1.9	94.0	47.3	22.9
Stationary Fuel Combustion					
Industry	8.3	7.9	0.2	0.5	10.3
Steam-Electric	86.0	67.1	0.4	1.0	62.2
Residential	1.9	0.3	0.4	0.6	1.1
Commercial and Institutional	1.9	0.5	0.4	0.5	1.2
Subtotal	98.4	75.8	1.4	2.6	74.8
Refuse Disposal					
Incineration	0.1	0.3	0.8	0.1	0.2
Open Burning	0.1	0.6	2.4	4.7	1.1
Subtotal	0.2	0.9	3.2	4.8	1.3
Process Losses	0.1	21.4	1.4	0.2	1.0
Evaporative Losses	--	--	--	45.1	--
TOTAL	100	100	100	100	100

DESCRIPTION OF STUDY AREA

The Study Area for the emission survey of the Charlotte Metropolitan Area consists of twelve counties--Cabarrus, Catawba, Cleveland, Gaston, Iredell, Lincoln, Mecklenburg, Rowan and Union all in North Carolina and Chester, Lancaster and York in South Carolina. The twelve county area is located in the south-western part of North Carolina and extends into South Carolina. Figure 1 shows the location of the Charlotte Study Area relative to other large cities in its vicinity.

Figure 2 represents a more detailed drawing of the Charlotte Study Area showing the major urban areas. It should be pointed out that the boundaries of these areas do not correspond to city limits, but rather give a general outline of the major clusters of population. The Study Area occupies 5,960 square miles and contained an estimated 1968 population of 1,115,000, which is approximately a 12 percent increase since 1960 (Table 3).³ The population density map (Figure 3) shows the heaviest concentrations near the city of Charlotte.

TOPOGRAPHY⁴

The Charlotte Study Area is located in the southern Piedmont and partially in the Catawba River Basin. The area acts as a connecting link between the steep to rolling hills of the mountain region to the west and the coastal plain to the east. The mountains extend from southwest to northeast, being about 80 or 90 miles from Charlotte on both the west and north. The general elevation of the area around Charlotte is about 730 feet, with the land rising toward the mountains to the southwest, west and north and decreasing toward the coastal plain to the east and southeast. The Catawba River and its tributaries run directly through the center of the Study Area from near its northern boundary around Catawba and Iredell Counties down into South Carolina.

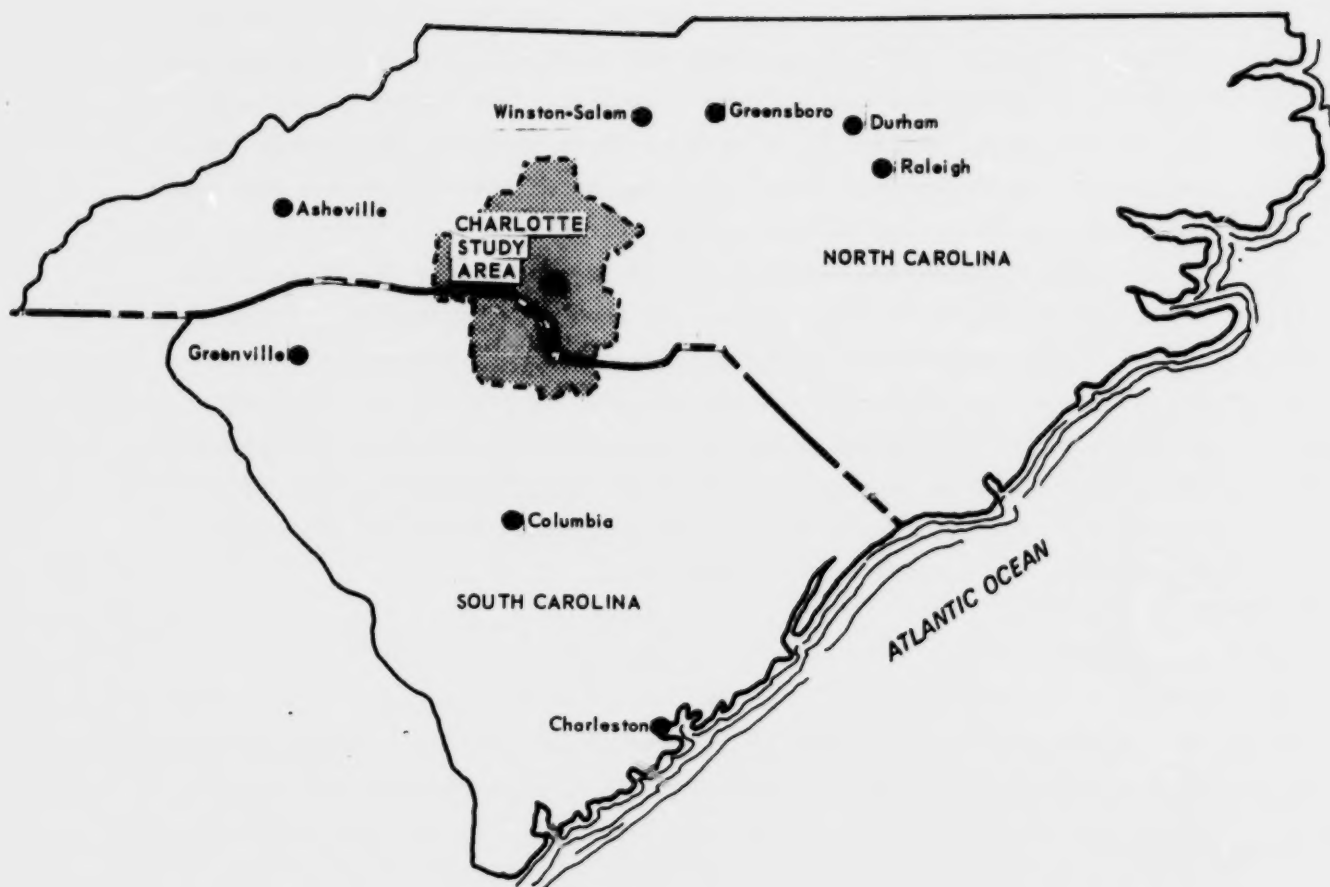


Figure 1. Map of the Charlotte study area and surrounding cities.

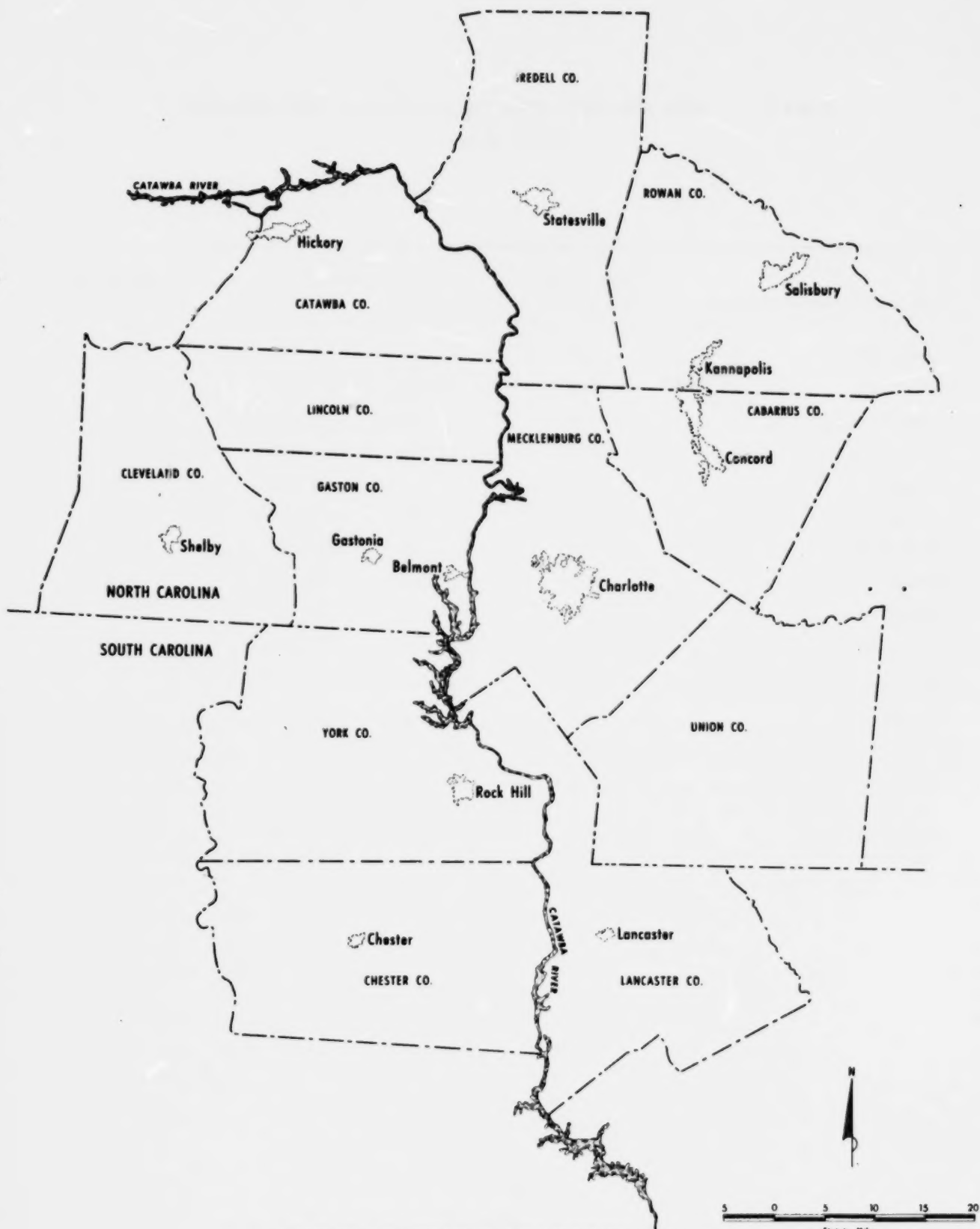


Figure 2. Detailed map of the Charlotte study area.

TABLE 3 AREA AND POPULATION CHARACTERISTICS FOR CHARLOTTE
STUDY AREA

Political Jurisdiction	Land Area (Sq. Mi.)	Population		Population Density (1968)
		1960	1968	
Cabarrus	360	68,100	74,700	207
Catawba	404	73,200	85,800	212
Cleveland	466	66,000	71,600	154
Gaston	358	124,100	143,100	400
Iredell	591	62,500	69,100	117
Lincoln	308	28,800	31,400	102
Mecklenburg	542	272,100	337,800	623
Rowan	517	82,800	89,100	172
Union	643	44,700	50,300	78
N. C. Subtotal	4,189	822,300	952,900	227
Chester	584	30,900	32,000	55
Lancaster	502	39,400	44,300	88
York	684	78,800	85,800	125
S. C. Subtotal	1,770	149,100	162,100	91
GRAND TOTAL	5,959	971,400	1,115,000	187

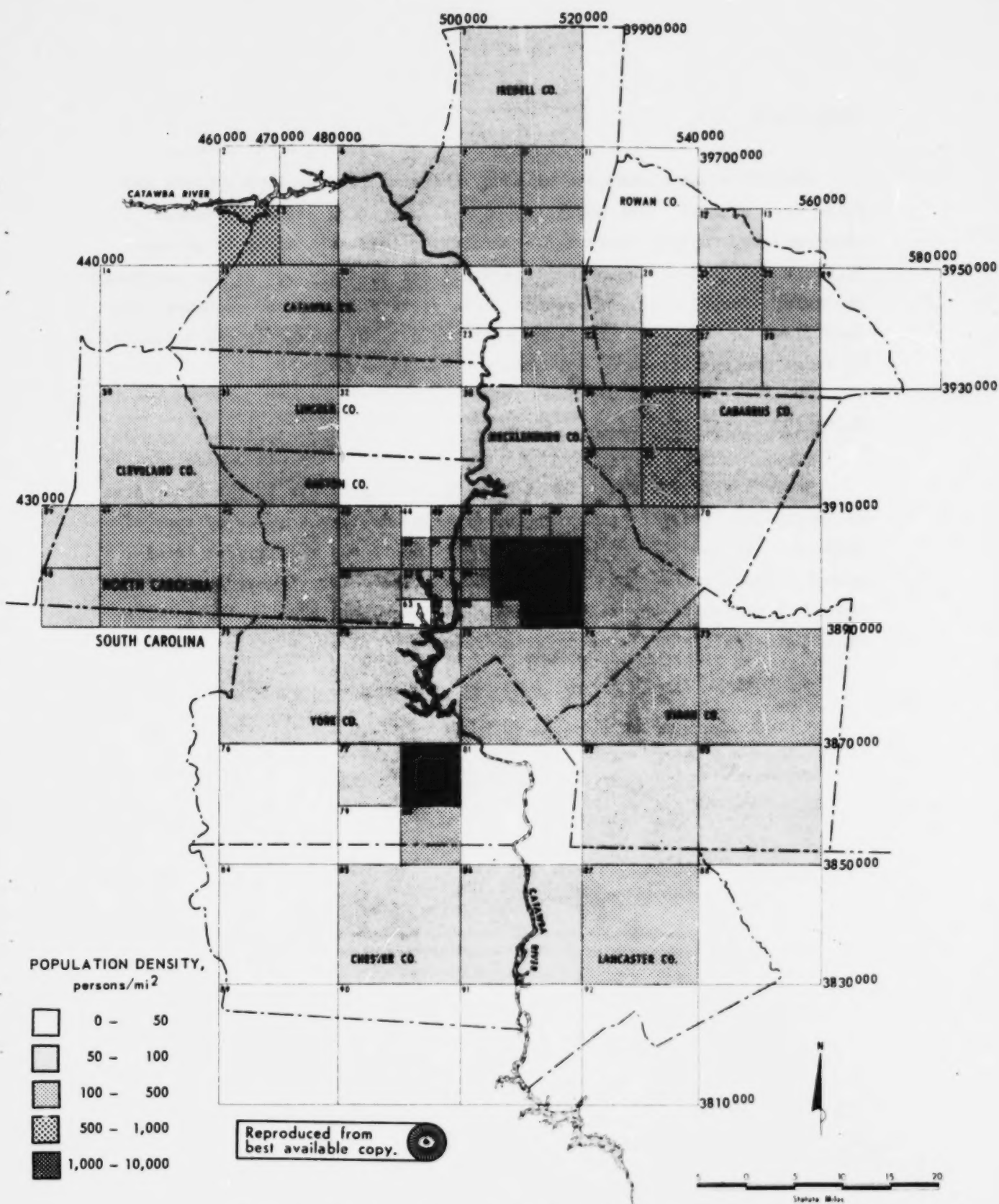


Figure 3. Population density for Charlotte study area, 1968.

CLIMATOLOGY

Charlotte has a moderate climate, characterized by cool winters and quite warm summers. The mountains have a moderating effect on winter temperatures, causing appreciable warming of cold air coming in on west or northwest winds. The prevailing winds are normally out of the northwest averaging around 7 mph. In general, the climatological and topographical conditions in the Charlotte Study Area are not conducive for the accumulation of large concentrations of pollutants.

MAJOR INDUSTRIAL FACTORS

Table 4 shows selected manufacturing establishments in the Study Area by county for 1968.^{5,6} Almost 1,000 establishments are shown by type of industry. As can be expected Mecklenburg County has the largest total number of establishments. The most interesting thing to note is the large number of plants in the textile industry. Over half the total establishments were textile mills or textile products.

TABLE 4 SELECTED MANUFACTURING ESTABLISHMENTS IN THE CHARLOTTE STUDY AREA, 1968

Jurisdiction	Grain Products	Textile Mill Products	Lumber, Wood Products	Paper, Allied Products	Chemicals	Rubber, Plastics	Stone			Fabricated Metals	Totale
							Clay	Glass	Primary Metals		
Cabarrus	1	30	2	1	0	1	2		0	1	38
Catawba	4	140	20	7	4	8	10		0	6	199
Cleveland	1	44	6	2	0	2	13		1	1	70
Gaston	1	116	12	1	5	4	5		4	8	156
Iredell	7	27	11	3	2	1	7		1	7	66
Lincoln	2	24	7	0	0	0	2		1	0	36
Mecklenburg	3	43	22	23	53	10	20		10	51	235
Rowan	6	19	10	1	5	1	13		2	6	63
Union	7	15	6	1	0	0	4		2	2	37
Chester	0	13	1	0	1	0	1		1	0	17
Lancaster	1	5	3	0	0	0	4		1	2	16
York	3	22	2	2	3	0	5		3	3	43
TOTAL	36	498	102	41	73	27	86		26	87	976

GRID COORDINATE SYSTEM

A grid coordinate system, based on the Universal Transverse Mercator Projection (UTM) was used in the Charlotte Study Area to show the geographical distribution of emissions. A map of this grid system is presented in Figure 4.

The UTM system was chosen due to its advantages over other standard grid systems such as the Latitude-Longitude and State Plane Coordinate Systems. The major advantages of this system are that (1) it is continuous across the country and is not hindered by political subdivisions, (2) the grids are of uniform size throughout the country, (3) it has world-wide use, and (4) the grids are square in shape--a necessary feature for use in meteorological dispersion models.

The Universal Transverse Mercator Projection is based upon the metric system. Each north-south and east-west grid line, as illustrated in Figure 4, is identified by a coordinate number expressed in meters. Each point source and grid is identified by the horizontal and vertical coordinates of their geographical center to the nearest 100 meters.

As shown in Figure 4, the Study Area was divided into 92 grids of three different sizes--25, 100, and 400 square kilometers. Grid zones of different sizes are used to limit the number of grid zones and yet allow a satisfactory definition of the geographical gradation of emissions. The majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area. Smaller grids are placed over these areas in order to reflect abrupt changes in emissions within short distances. The use of grid zones smaller than 25 square kilometers is not warranted because of the inherent inaccuracies in the data. Since only a small percentage of the total emissions occur in rural areas, larger grid zones are normally used to show the distribution of emissions in these lightly populated portions of a Study Area.

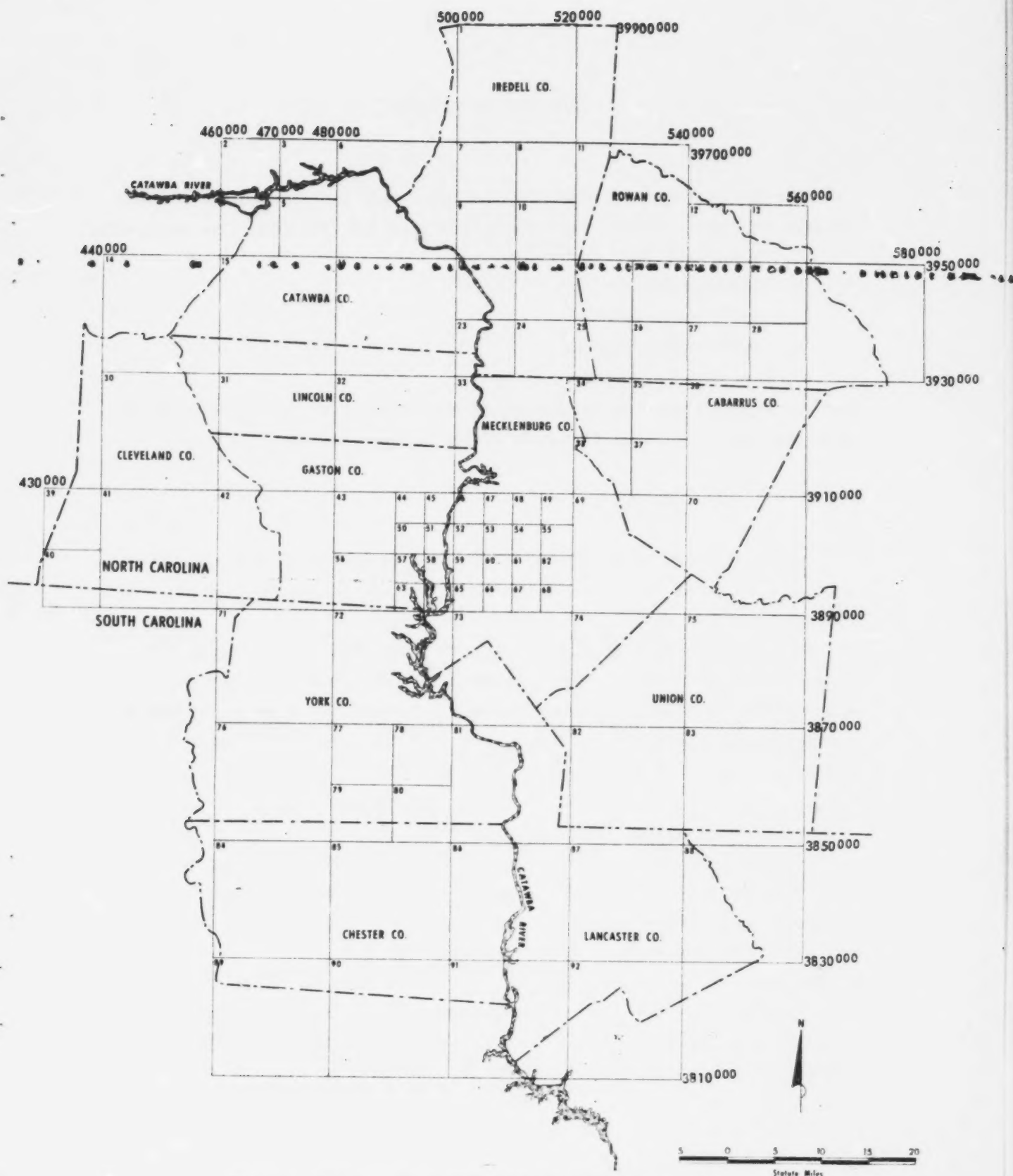


Figure 4. Grid coordinate system for the Charlotte study area.

EMISSIONS BY CATEGORY

For the purposes of compiling the basic data and emission estimates, the air pollutant sources were classified into the following five categories:

1. Stationary fuel combustion
2. Transportation
3. Solid waste disposal
4. Industrial processes
5. Evaporative losses

Each of these categories is considered individually in this section where data sources are given and methods of calculation discussed.

STATIONARY FUEL COMBUSTION

The stationary fuel combustion category is concerned with any fixed source which burns fuels for either space heating or process heating. The four primary sources in this category are industrial facilities, steam-electric plants, residential housing, and commercial and institutional establishments. In the Charlotte area, coal, distillate oil and residual oil were all in widespread use. Tables 5 through Table 8 present a summary of the fuels consumed in the Study Area, and Table 9 presents an average chemical analysis of these fuels.

Steam-Electric Utility

METHODOLOGY: Data on the five power plants in the area were acquired from the Duke Power Company and compared to figures presented by the National Coal Association.⁷ The data included the annual fuel consumption for 1968, type and efficiency of control equipment, sulfur and ash content of the fuel and the type of furnace.

RESULTS: All five of the power plants in the area use pulverized coal-fired boilers which range in size from 300 million BTU/hr. - 2,800 million BTU/hr. Approximately 9 million tons of coal were consumed in these boilers

TABLE 5 ANNUAL CONSUMPTION OF NATURAL GAS IN THE CHARLOTTE STUDY AREA, 1968
(Million Cubic Feet)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Cabarrus	--	1,940	440	150	2,530
Catawba	--	1,570	350	280	2,200
Cleveland	--	2,000	380	250	2,630
Gaston	--	5,000	1,530	460	6,990
Iredell	--	2,050	500	200	2,750
Lincoln	--	330	130	70	530
Mecklenburg	--	3,120	4,340	2,400	9,860
Rowan	--	2,590	340	230	3,160
Union	--	500	90	40	630
N. C. Subtotal	--	19,100	8,100	4,080	31,280
Chester	--	350	290	200	840
Lancaster	--	750	300	200	1,250
York	--	27,300	510	300	28,110
S. C. Subtotal	--	28,400	1,100	700	30,200
GRAND TOTAL	--	47,500	9,200	4,780	61,480

TABLE 6 ANNUAL CONSUMPTION OF COAL IN THE CHARLOTTE STUDY AREA, 1968
(Tons)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Cabarrus	--	65,000	9,000	9,000	83,000
Catawba	2,216,000	14,600	5,800	3,000	2,239,400
Cleveland	610,400	30,300	13,300	6,700	660,700
Gaston	5,031,600	32,000	20,500	6,000	5,090,100
Iredell	--	4,000	6,600	3,000	13,600
Lincoln	--	2,300	5,000	900	8,200
Mecklenburg	--	35,000	25,100	25,000	85,100
Rowan	1,228,600	65,000	10,000	12,000	1,315,600
Union	--	500	4,000	3,000	7,500
N. C. Subtotal	9,086,600	248,700	99,300	68,600	9,503,200
Chester	--	NA	2,700	1,000	3,700
Lancaster	--	135,000	4,300	3,000	142,300
York	--	250,000	12,100	3,000	265,100
S. C. Subtotal	--	385,000	19,100	7,000	411,100
GRAND TOTAL	9,086,600	633,700	118,400	75,600	9,914,300

NA = Information not available or not reported.

TABLE 7 ANNUAL CONSUMPTION OF RESIDUAL FUEL OIL IN THE CHARLOTTE STUDY AREA, 1968
(1,000 Gallons)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Cabarrus	--	1,600	--	400	2,000
Catawba	--	1,200	--	300	1,500
Cleveland	--	2,300	--	200	2,500
Gaston	--	3,500	--	500	4,000
Iredell	--	1,600	--	400	2,000
Lincoln	--	800	--	200	1,000
Mecklenburg	--	3,000	--	2,200	3,500
Rowan	--	3,000	--	500	3,500
Union	--	900	--	100	1,000
N. C. Subtotal	--	17,900	--	4,600	22,500
Chester	--	800	--	200	1,000
Lancaster	--	1,000	--	100	1,100
York	--	6,100	--	300	6,400
S. C. Subtotal	--	7,900	--	600	8,500
GRAND TOTAL	--	25,800	--	5,200	31,000

TABLE 8 ANNUAL CONSUMPTION OF DISTILLATE FUEL OIL IN THE CHARLOTTE STUDY AREA, 1968
(Gallons)

Jurisdiction	Steam-Electric	Industrial	Residential	Commercial and Institutional	Totals
Cabarrus	--	5,000,000	7,600,000	1,400,000	14,000,000
Catawba	243,500	5,500,000	9,500,000	1,000,000	16,243,500
Cleveland	200,500	6,500,000	4,000,000	1,500,000	12,200,500
Gaston	1,009,000	7,000,000	9,100,000	2,000,000	19,109,000
Iredell	--	6,000,000	5,000,000	2,000,000	13,000,000
Lincoln	--	2,500,000	2,500,000	500,000	5,500,000
Mecklenburg	--	26,000,000	21,100,000	18,000,000	65,100,000
Rowan	347,700	7,000,000	10,000,000	1,000,000	18,347,700
Union	--	3,500,000	4,500,000	1,000,000	9,000,000
N. C. Subtotal	1,800,700	69,000,000	73,300,000	28,400,000	172,500,000
Chester	--	2,000,000	1,000,000	NA	3,000,000
Lancaster	--	500,000	2,400,000	NA	2,900,000
York	--	1,000,000	5,900,000	NA	6,900,000
S. C. Subtotal	--	3,500,000	9,300,000	NA	12,800,000
GRAND TOTAL	1,800,700	72,500,000	82,600,000	28,400,000	185,300,000

TABLE 9 AVERAGE CHEMICAL ANALYSIS OF FUELS CONSUMED IN THE
CHARLOTTE STUDY AREA, 1968

Type Fuel	Type Source	% by weight Ash Content	% by Weight Sulfur Content
Coal	Steam-Electric	12.0	1.0
	Industrial	8.0	1.0
	Domestic-Commercial	6.0	0.9
Residual Fuel Oil	Steam-Electric	NU	NU
	Industrial	N	1.5
	Domestic-Commercial	NU	NU
Distillate Fuel Oil	Steam-Electric	N	0.2
	Industrial	N	0.2
	Domestic-Commercial	N	0.15

N = Negligible

NU = Fuel not used by this type source

in 1968. Of this 9 million tons, 1.1 million was consumed in boilers with no control devices for particulates. The remaining 7.9 million tons were controlled by either a mechanical (multiple cyclone) collector or an electrostatic precipitator. The efficiencies of these controls ranged from a low of 65 percent with an overloaded mechanical collector to 95 percent with electrostatic precipitators. The average weighted efficiency of the 7.9 million tons of coal which was controlled was 80 percent. A total of 1.8 million gallons of distillate fuel oil was also used by the five power plants. This oil was used for "light off" and flame stabilization of the boilers during start-up conditions.

Air pollutant emissions from fuel combustion at these plants as well as from all other fuel combustion sources are summarized in Table 10. The steam-electric plants were the largest sources of sulfur oxides, particulates and nitrogen oxides in the Study Area. Over 87 percent of the total nitrogen oxides from stationary fuel combustion, 89 percent of the particulates, and 83 percent of the nitrogen oxides were attributed to these five plants.

Industrial

METHODOLOGY: Since in a rapid survey of industrial sources it is impossible to contact every plant, other techniques must be used to determine the contribution of industrial fuel combustion sources. In order to do this, the total quantities of the various fuels used are determined and the amounts used by the largest industries are found. The remaining sources are considered collectively as area sources and their fuel use is based on the difference between the total and the amount consumed by the largest sources.

The total quantities of residual and distillate fuel oil consumed by industries were estimated by the North Carolina Oil Fuel Institute and by the South Carolina Oil Fuel Institute. These were compared to totals provided by the majority of the acknowledged agencies. Natural gas numbers were obtained from each of the local suppliers who provided the breakdown by user category. Total coal consumption by industrial sources was based solely on questionnaire data or personal contacts made by the local agencies.

TABLE 10 AIR POLLUTANT EMISSIONS FROM THE COMBUSTION OF FUELS IN
STATIONARY SOURCES IN THE STUDY AREA, 1968 (Tons/Year)

Fuel User Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Coal					
Industrial	12,100	27,800	1,000	300	6,300
Steam-Electric	171,900	246,000	2,200	900	89,900
Residential	1,700	500	2,200	400	400
Commercial and Institutional	1,400	1,600	1,900	400	300
Subtotal	187,100	275,900	7,300	2,000	96,900
Fuel Oil					
Industrial	4,500	840	100	100	3,600
Steam-Electric	30	10	N	N	100
Residential	840	280	70	100	400
Commercial and Institutional	1,030	270	30	30	1,200
Subtotal	6,400	1,400	200	230	5,300
Gas					
Industrial	10	420	10	N	5,000
Steam-Electric	N	N	N	N	N
Residential	N	100	N	N	600
Commercial and Institutional	N	20	N	N	100
Subtotal	10	540	10	N	5,700
GRAND TOTAL ^a	193,500	277,800	7,500	2,200	107,900

N = Negligible

a = Totals have been rounded.

The quantities of all fuels used by individual industries was found by the local agencies and then subtracted from the totals to determine area source fuel use.

It should be noted that fuel combustion by industries include both fuel used for space heating, and fuel used for process heating. A national average was used to separate process heating from space heating.

RESULTS: Coal, distillate oil, residual oil and natural gas were all used by industrial sources in the Study Area. The consumption of these fuels is summarized in Tables 5 through 8.

Table 10 shows the relative contribution of each fuel to the total emissions from stationary fuel combustion. Industrial sources account for 8 percent of total sulfur oxide emissions from stationary fuel combustion, 10 percent of particulates, 14 percent of carbon monoxide, 17 percent of hydrocarbons, and 14 percent of nitrogen oxides.

Residential

METHODOLOGY: Natural gas, distillate fuel oil and coal were the primary fuels used for residential home heating. There were homes heated by other fuels, but they represent a small percentage of the total. Data on the amount of natural gas used for domestic heating was supplied by the local power companies and compared with the rapid survey technique of estimating the fuel used for home heating.⁸ Distillate oil and coal consumption data were estimated based on data supplied by local agencies and on the rapid survey technique.

RESULTS: Table 11 gives an estimate of the number of homes that use each type fuel in the Study Area. The percentage of the number of homes that use each type fuel is fairly constant with natural gas being used in 46 percent of the dwelling units, fuel oil 41 percent and coal 13 percent.

Emissions resulting from residential fuel combustion are relatively low for all pollutants. However, since coal is not burned efficiently in homes, carbon monoxide and hydrocarbons are higher than might be expected. The contribution to total emissions from stationary fuel combustion by domestic heating was less than 1 percent for any pollutant except for carbon monoxide (29%) and hydrocarbons (18%).

TABLE 11 SUMMARY OF DOMESTIC HEATING BY NUMBER OF DWELLING UNITS
IN THE CHARLOTTE STUDY AREA, 1968

Jurisdiction	Coal	Fuel Oil	Natural Gas
Cabarrus	2,300	12,000	5,200
Catawba	1,500	14,900	4,100
Cleveland	3,400	6,200	6,200
Gaston	5,300	14,200	18,100
Iredell	1,700	7,800	5,900
Lincoln	1,300	3,900	1,500
Mecklenburg	6,400	33,100	51,400
Rowan	2,600	15,600	4,000
Union	1,000	7,100	1,100
North Carolina Portion	25,500	84,800	97,500
Percent of Total	12%	41%	47%
Chester	700	1,700	3,500
Lancaster	1,100	3,700	3,600
York	3,100	9,300	6,000
South Carolina Portion	4,900	14,700	13,100
Percent of Total	15%	45%	40%
GRAND TOTAL	30,400	99,500	110,600
OVERALL PERCENTAGE	13%	41%	46%

Commercial-Institutional

METHODOLOGY: Commercial and institutional establishments in the Study Area used all four of the previously mentioned fuels--distillate and residual oil, natural gas and coal. Data on the total amounts of these fuels used in the area as well as the consumption at individual establishments were supplied by power companies, fuel associations and the local agencies.

RESULTS: The use of coal and fuel oil at commercial and institutional establishments was by far the most significant source of emissions from this category. The contribution to total stationary fuel combustion emissions from these establishments was relatively minor.

TRANSPORTATION

Three types of transportation sources of air pollution are considered in this survey--motor vehicles, aircraft, and railroads. Motor vehicles, which are by far the most significant source in this category, are further subdivided according to type of fuel--gasoline or diesel.

Motor Vehicles

More than 17 million miles were traveled by motor vehicles in 1968 in the Charlotte Study Area. In the process, 405 million gallons of gasoline and 73 million gallons of diesel fuel were consumed for highway purposes. Table 12 shows the miles of travel for gasoline and diesel vehicles for each county in the Study Area.

Vehicle-mile data for essentially all of the roads in Mecklenburg County were supplied by the State Highway Department. For Mecklenburg County, this data was in the form of traffic flow maps which showed average daily traffic along the roads. In Gaston, Iredell, York, Chester and Lancaster Counties traffic flow maps were used to determine vehicle miles in the major cities and gasoline consumption was used to determine county wide totals. In the remaining counties, vehicle-mile information was not

TABLE 12 VEHICLE MILES OF TRAVEL FOR MOTOR VEHICLES IN THE
CHARLOTTE STUDY AREA, 1968 (Vehicle Miles/Day)

Jurisdiction	Gasoline Vehicle Miles	Diesel Vehicle Miles	Total
Cabarrus	1,128,000	72,000	1,200,000
Catawba	1,316,000	84,000	1,400,000
Cleveland	940,000	60,000	1,000,000
Gaston	2,068,000	132,000	2,200,000
Iredell	1,034,000	66,000	1,100,000
Lincoln	461,000	29,000	490,000
Mecklenburg	5,170,000	330,000	5,500,000
Rowan	1,222,000	78,000	1,300,000
Union	677,000	43,000	720,000
N. C. Subtotal	14,016,000	894,000	14,910,000
Chester	395,000	25,000	420,000
Lancaster	658,000	42,000	700,000
York	940,000	60,000	1,000,000
S. C. Subtotal	1,993,000	127,000	2,120,000
GRAND TOTAL	16,009,000	1,021,000	17,030,000

available, and thus gasoline consumption alone was used to find vehicular emissions.⁹

The contribution to the total motor vehicle pollution by diesel-powered vehicles was determined by assuming that approximately six percent of the total vehicle miles traveled were by diesel-powered vehicles. This was checked by estimating diesel fuel consumption in each county.¹⁰ These emissions were apportioned on a grid basis by assuming they were proportional to gasoline emissions.

Emissions from motor vehicles are a function of the speed at which the vehicle travels. Average speeds of 10-20 mph were assumed for downtown areas, 20-30 mph for the residential areas, and 30-45 mph for the rural areas to calculate vehicle emissions.

From all transportation sources, motor vehicles accounted for 92 percent of the sulfur oxides, 86 percent of the particulates, 99 percent of the carbon monoxide, 95 percent of the hydrocarbons, and 94 percent of the nitrogen oxides. Gasoline powered motor vehicles contributed a greater percent of all pollutants than diesel powered motor vehicles. Emissions from transportation sources are summarized in Table 13.

Aircraft

Table 14 shows the air traffic activity at the largest airports in the Study Area. An estimate of the number of flights by engine type was supplied by the traffic controller at each airport and summarized in Table 14.

The air pollutant emissions from aircraft include all phases of operation (taxi, take-off, climb out, approach and landing) that take place below the arbitrarily chosen altitude of 3,500 feet. Emissions at cruise altitude (above 3,500 feet) are not of concern in an emission inventory. From all transportation sources, aircraft accounted for 3 percent of the particulates, 1 percent of the carbon monoxide, 3 percent of the hydrocarbons and 1 percent of the nitrogen oxides.

Railroads

Railroad operations (mainly locomotive) consume about 13 million gallons of diesel fuel per year within the Study Area. This quantity is about 80 percent less than the amount of diesel fuel consumed by motor vehicles. The majority of this fuel is consumed during switching operations. Diesel

TABLE 13 SUMMARY OF AIR POLLUTANT EMISSIONS FROM TRANSPORTATION
SOURCES, 1968 (Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Motor Vehicles					
Gasoline	1,700	2,200	490,300	36,400	23,500
Diesel	1,400	3,800	2,100	4,700	7,700
Subtotal	3,100	6,000	492,400	41,100	31,200
Aircraft					
Jet	N	200	200	130	140
Piston	N	30	6,400	1,200	300
Turboprop	N	N	N	N	N
Subtotal	N	230	6,600	1,330	440
Railroads	270	750	400	920	1,510
GRAND TOTAL	3,370	6,980	499,400	43,350	33,150

TABLE 14 AIR TRAFFIC ACTIVITY AT THE LARGEST AIRPORTS IN THE
CHARLOTTE STUDY AREA, 1968 (Flights/Year)^a

Type Engine	Douglas	Delta	Carpenter	Brocenbrough
2 Engine Conventional Jet	21,200	--	--	--
3 Engine Fan-Jet	6,200	--	--	--
4 Engine Fan-Jet	1,500	--	--	--
2 Engine Turboprop	2,200	--	--	--
1 Engine Piston	29,200	2,000	12,000	12,000
2 Engine Piston	20,100	--	1,600	1,400
4 Engine Piston	3,700	--	--	--
TOTALS	84,100	2,000	13,600	13,400

a - Flight is defined as a combination of a landing and a takeoff.

fuel consumption data were supplied by each of the major railroads in the Charlotte area.

Railroad operations contribute about 8 percent of the sulfur oxides and 10 percent of the particulates from all transportation sources. They account for less than 4 percent of the emissions for any other pollutant.

SOLID WASTE DISPOSAL

Approximately 2 million tons of refuse was generated during 1968 within the Study Area. Table 15 presents a solid waste balance for the Charlotte Study Area, showing the various methods of disposal and the quantities disposed of by each method. Only in Mecklenburg County was there no waste burned as standard practice. In Cleveland and Lincoln Counties there were no open burning dumps, but there was some backyard burning. In the rest of the North Carolina Counties, the bulk of the refuse was disposed of in landfills or non-burning dumps. However, in each of these counties there were some open burning dumps with Cabarrus and Rowan having the largest contribution to open burning from dumps. In the South Carolina counties the most widely used method of disposal was the open burning dump.

For the entire Study Area 1 percent of the refuse was disposed of by municipal incinerators, 10 percent by on-site incinerators, 72 percent by landfills or non-burning dumps, 10 percent by open burning dumps and 7 percent by backyard burning. Refuse data for all of the North Carolina counties were supplied by each local agency. For the South Carolina counties the South Carolina Board of Health, Solid Waste Division provided the data.

Incineration

In the Charlotte Study Area there was only one municipal incinerator used to dispose of solid waste. This was a relatively small incinerator located in Cleveland County. The amount of refuse disposed of by on-site incineration was assumed to be approximately 10 percent of the generated refuse in each county. In all counties the 198,000 tons of refuse burned by on-site incinerators was treated as an area source and apportioned onto grids by population. No incinerators were classified as point sources.

TABLE 15 SOLID WASTE BALANCE FOR CHARLOTTE STUDY AREA, 1968 (Tons/Year)

Political Jurisdiction	Total Refuse Generated	Incineration		Landfills or Non Burning Dumps		Open Burning	
		Municipal	On-Site			Dumps	On-Site
Cabarrus	134,000	--	13,400	90,000	30,600	NA	NA
Catawba	154,000	--	15,400	133,800	4,800	--	--
Cleveland	127,400	3,900	13,000	78,000	--	32,500	32,500
Gaston	258,000	--	25,800	186,200	26,000	20,000	20,000
Iredell	124,000	--	12,400	105,000	6,600	NA	NA
Lincoln	57,000	--	5,700	50,800	500	--	--
Mecklenburg	613,000	--	61,000	549,000	--	--	--
Rowan	138,000	--	13,200	69,000	52,300	3,500	3,500
Union	90,000	--	9,000	71,000	10,000	NA	NA
N. C. Subtotal	1,692,400	3,900	168,900	1,332,800	156,800	30,000	30,000
Chester	58,000	--	5,800	29,700	5,100	17,400	17,400
Lancaster	80,000	--	8,000	7,000	22,500	42,500	42,500
York	154,000	--	15,400	63,400	29,000	46,200	46,200
S. C. Subtotal	292,000	--	29,200	100,100	56,600	106,100	106,100
GRAND TOTALS	1,984,400	3,900	198,100	1,432,900	213,400	136,100	136,100

NA = Not available or not reported.

The incineration of refuse contributed 59 percent of the total sulfur oxide emissions from solid waste disposal, 32 percent of the particulates, 26 percent of the carbon monoxide, 2 percent of the nitrogen oxides and 16 percent of the hydrocarbons.

Open Burning

The two major categories of open burning are open burning dumps and on-site open burning. Open burning dumps were the largest contributors to the air pollution from solid waste disposal. There were over 40 open burning dumps in the Study Area, ten of which were classified as point sources. The open burning of approximately 100,000 tons of waste in backyards was also a significant factor in solid waste disposal. This 100,000 tons was treated as area source emissions and apportioned onto grids by population.

The open burning of refuse contributed 41 percent of total sulfur oxide emissions from solid waste disposal, 68 percent of the particulates, 74 percent of the carbon monoxide, 98 percent of the nitrogen oxides and 84 percent of the hydrocarbons.

INDUSTRIAL PROCESSES

The Study Area is characterized by the large number of textile mills. The operations that take place at these mills are of little concern in an emission inventory. From an air pollution standpoint the food and agricultural industry and mineral products industry were by far the most significant industrial process sources. In the food and agricultural industry the largest sources were 6 feed and grain mills and elevators, and 2 fertilizer plants. In the mineral products industry the largest sources were 2 brick manufacturers, 7 asphalt batching plants, 1 mining site, and 6 rock processing operations. The only other large industrial process source was a paper and pulp mill. Other industries that generated air pollutant emissions from their processes included 3 small scale gray iron foundries, 1 steel fabrication plant, 2 chemical plants and numerous conical burners associated with lumber products. Table 17 presents a summary of the emissions from the various industrial processes.

Over 2 million tons of brick were manufactured by the two plants in the Study Area. It was assumed that both of these plants employed

TABLE 16 AIR POLLUTANT EMISSIONS FROM SOLID WASTE DISPOSAL, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Incineration					
Municipal	N	20	N	N	N
On-Site	200	990	4,360	80	300
Subtotal	200	1,110	4,360	80	300
Open Burning					
On-Site	50	820	4,360	1,540	560
Dump	90	1,500	7,950	2,810	1,030
Subtotal	140	2,320	12,310	4,350	1,590
GRAND TOTAL	340	3,430	16,670	4,430	1,890

N--Negligible

TABLE 17 SUMMARY OF AIR POLLUTANT EMISSIONS FROM INDUSTRIAL
PROCESSES, 1968 (Tons/Year)

Type Industry	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Mineral Products					
Brick Manufacturing	--	20,000	--	--	--
Asphalt Batching	--	2,100	--	--	--
Mining	--	5,700	--	--	--
Rock Processing	--	29,500	--	--	--
Subtotal	--	57,300	--	--	--
Metallurgical					
Gray Iron Foundry	--	900	6,200	--	--
Steel Fabrication	--	30	--	--	--
Pulp and Paper	270	9,100	270	130	1,300
Lumber Products	--	200	1,200	100	30
Food and Agricultural					
Feed and Grain	--	3,100	--	--	--
Fertilizer	--	6,300	--	--	--
Subtotal	--	9,400	--	--	--
Chemicals	--	1,200	--	--	--
GRAND TOTALS	270	77,200	7,670	230	1,330

some type of control for dust emissions. These plants accounted for 26 percent of the process particulates.

The seven asphalt batching plants in the Study Area produced over 1.2 million tons of hot mix asphalt. These 7 plants accounted for less than 3 percent of the particulates from industrial processes. Approximately 570,000 tons of wet rock were mined at the one mine-site in the Study Area. The dust emissions from this site accounted for 7 percent of total process particulates.

Over 4 million tons of rock were processed at the 6 active quarries in the Study Area. Crushing, screening and other operations at these plants accounted for 38 percent of the total emissions from industrial processes.

The area included in the Charlotte Study Area has 6 feed and grain operations of a significant size. These plants processed more than 650,000 tons of feed and grain in 1968. Most of these plants are equipped with cyclones to control dust emissions. The primary source of dust emissions from the mills was the cleaning operations. Receiving, handling, and storage operations also contributed to the dust emissions. Approximately 4 percent of the particulates from all industrial processes are emitted from the feed and grain industry.

Approximately 180,000 tons of fertilizer were processed by the two fertilizer plants in the area. It was assumed that about 3 to 4 percent of the amount processed was lost as particulate emissions. These two plants accounted for 8 percent of industrial process particulates.

The remaining 14 percent of the particulate emissions from industrial processes was distributed among other minor operations as shown in Table 17.

EVAPORATIVE LOSSES

Three source categories were considered for evaporative losses-- automobiles, gasoline storage and handling, and the consumption of solvents. The hydrocarbon emissions from all sources by evaporative losses are shown in Table 18.

Automobiles

Automobile evaporation losses include gas tank and carburetor evaporation

TABLE 18 HYDROCARBON EMISSIONS FROM EVAPORATIVE LOSS SOURCES IN
THE CHARLOTTE STUDY AREA, 1968 (Tons/Year)

Type of Source	Hydrocarbons
Gasoline Storage and Handling	6,500
Automobiles	23,200
Solvent Consumption	
Industrial	7,800
Dry Cleaning	2,200
Domestic-Commercial	1,600
GRAND TOTAL	41,300

and engine crankcase blowby. Since 1963, most new automobiles were equipped with positive crankcase ventilation (PCV) valves that reduce hydrocarbon emissions from the crankcase by about 90 percent. Due to a lag time in the automobile replacement rate, it was assumed that 20 percent of the automobiles were not equipped with PCV valves.

The hydrocarbon emissions from automobiles were calculated from vehicle-mile data and were apportioned onto grids using the same methods as for motor vehicles discussed earlier. Evaporative losses from automobiles accounted for 56 percent of the total hydrocarbon emissions from evaporative losses in the Study Area.

Gasoline Storage and Handling

There are four major points (excluding evaporation from the motor vehicle) of hydrocarbon emissions in the storage and handling of gasoline. There are:

1. Breathing and filling losses from storage tanks
2. Filling losses from loading tank conveyances
3. Filling losses from loading underground storage tanks at service stations.
4. Spillage and filling losses in filling automobile gas tanks at service stations.

Approximately 470 million gallons of gasoline and diesel fuel were stored in the Study Area in 1968. The evaporative losses from this storage and the subsequent handling accounted for 16 percent of the total evaporative losses.

Consumption of Solvents

This category included the consumption of solvents at dry cleaning plants, industrial solvent usage and the miscellaneous use of solvents by small commercial establishments and domestic units. Organic solvents emitted from these operations were determined by assuming an emission rate of 4 lb/capita/year for any cleaning plants, 13 lb/capita/year for industries and 3 lb/capita/year for miscellaneous consumption.^{11,12} The consumption of solvents by these three categories accounted for 28 percent of the hydrocarbon emissions from evaporative losses.

EMISSIONS BY JURISDICTION

The previous section presented the air pollutant emissions by source category. In order to show the contribution of each county to the pollution in the entire Study Area, their emissions are summarized in Tables 19 through 30.

As can be expected, since power plants play such a big part in the overall air pollution in the Study Area, the counties with power plants seem to be the most significant from a sulfur oxide particulate and nitrogen oxide standpoint.

Because of the higher degree of urbanization than the other counties and corresponding higher vehicular activity, Mecklenburg County contributes the majority of the carbon monoxide and hydrocarbons.

TABLE 19 SUMMARY OF AIR POLLUTANT EMISSIONS IN CABARRUS COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	230	450	35,700	3,010	2,320
Other	20	50	30	60	100
Subtotal	250	500	35,730	3,070	2,420
Stationary Fuel Combustion					
Industry	1,590	3,500	100	40	1,100
Steam-Electric	--	--	--	--	--
Residential	220	80	190	50	90
Commercial and Institutional	250	150	230	50	100
Subtotal	2,050	3,730	520	140	1,290
Refuse Disposal					
Incineration	10	70	290	N	20
Open Burning	20	240	1,300	460	170
Subtotal	30	310	1,590	460	190
Industrial Processes	--	--	--	--	--
Evaporative Losses	--	--	--	2,960	--
GRAND TOTAL^a	2,300	4,500	37,800	6,600	3,900

N = Negligible

a = Totals have been rounded.

TABLE 20 SUMMARY OF AIR POLLUTANT EMISSIONS IN CATAWBA COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Road Vehicles	260	520	39,900	3,400	2,710
Other	20	60	30	70	120
Subtotal	280	580	39,930	3,470	2,830
Stationary Fuel Combustion					
Industry	500	740	30	10	560
Steam-Electric	42,100	32,440	550	220	22,200
Residential	190	70	130	40	90
Commercial and Institutional	100	50	80	20	60
Subtotal	42,890	33,300	790	290	22,810
Refuse Disposal					
Incineration	10	80	340	10	20
Open Burning	N	40	200	70	30
Subtotal	10	120	540	80	50
Industrial Processes	--	3,000	240	20	--
Evaporative Losses	--	--	--	3,450	--
GRAND TOTAL ^a	43,200	37,000	41,500	7,300	25,700

N = Negligible

a = Totals have been rounded.

TABLE 21 SUMMARY OF AIR POLLUTANT EMISSIONS IN CLEVELAND COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	20	40	2,720	240	190
Other	20	50	30	60	100
Subtotal	40	90	2,750	300	290
Stationary Fuel Combustion					
Industry	900	1,650	50	20	830
Steam-Electric	12,800	33,300	150	60	6,110
Residential	250	80	280	60	90
Commercial and Institutional	170	110	170	40	90
Subtotal	14,120	35,140	650	180	7,120
Refuse Disposal					
Incineration	20	90	290	N	20
Open Burning	10	210	1,100	390	140
Subtotal	30	300	1,390	390	160
Industrial Processes	--	5,860	--	--	--
Evaporative Losses	--	--	--	1,250	--
GRAND TOTAL ^a	14,200	41,400	4,800	2,100	7,600

N = Negligible

a = Totals have been rounded.

TABLE 22 SUMMARY OF AIR POLLUTANT EMISSIONS IN GASTON COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	410	820	64,250	5,440	4,260
Other	40	100	50	120	190
Subtotal	450	920	64,300	5,560	4,450
Stationary Fuel Combustion					
Industry	1,510	2,200	60	30	1,250
Steam-Electric	93,700	107,200	1,230	490	49,400
Residential	420	150	430	100	200
Commercial and Institutional	200	110	150	30	100
Subtotal	95,830	109,660	1,870	650	50,950
Refuse Disposal					
Incineration	30	130	570	10	40
Open Burning	20	370	1,950	690	250
Subtotal	50	500	2,520	700	290
Industrial Processes	--	6,880	--	--	--
Evaporative Losses	--	--	--	5,530	--
GRAND TOTAL ^a	96,300	118,000	68,700	12,400	55,700

^a = Totals have been rounded.

TABLE 23 SUMMARY OF AIR POLLUTANT EMISSIONS IN IREDELL COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	210	410	29,200	2,550	2,130
Other	20	50	30	50	90
Subtotal	210	460	29,230	2,600	3,220
Stationary Fuel Combustion					
Industry	350	240	10	10	530
Steam-Electric	--	--	--	--	--
Residential	160	50	140	30	80
Commercial and Institutional	130	60	80	20	100
Subtotal	640	350	230	60	710
Refuse Disposal					
Incineration	10	60	270	N	20
Open Burning	N	50	280	100	40
Subtotal	10	110	550	100	60
Industrial Processes	--	2,710	--	--	--
Evaporative Losses	--	--	--	2,730	--
GRAND TOTAL ^a	900	3,600	30,000	5,500	4,000

N = Negligible

a = Totals have been rounded.

TABLE 24 SUMMARY OF AIR POLLUTANT EMISSIONS IN LINCOLN COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	90	180	13,450	1,160	950
Other	10	20	10	30	40
Subtotal	100	200	13,460	1,190	990
Stationary Fuel Combustion					
Industry	170	120	10	N	140
Steam-Electric	0	0	0	0	0
Residential	100	30	100	20	40
Commercial and Institutional	50	20	20	N	30
Subtotal	320	170	130	20	210
Refuse Disposal					
Incineration	N	30	120	N	10
Open Burning	N	N	20	10	N
Subtotal	N	30	140	10	10
Industrial Processes	--	10	40	N	--
Evaporative Losses	--	--	--	1,206	--
GRAND TOTAL ^a	400	400	13,800	2,400	1,200

N = Negligible

a = Totals have been rounded.

TABLE 25 SUMMARY OF AIR POLLUTANT EMISSIONS IN MECKLENBURG COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	1,040	2,060	186,000	15,050	10,600
Other	80	460	6,700	1,620	900
Subtotal	1,120	2,520	192,700	16,670	11,500
Stationary Fuel Combustion					
Industry	1,400	2,070	80	50	1,730
Steam-Electric	--	--	--	--	--
Residential	600	240	540	130	440
Commercial and Institutional	970	630	640	140	960
Subtotal	2,970	2,940	1,260	320	3,130
Refuse Disposal					
Incineration	60	300	1,340	20	90
Open Burning	--	--	--	--	--
Subtotal	60	300	1,340	20	90
Industrial Processes	N	25,400	580	--	30
Evaporative Losses	--	--	--	13,600	--
GRAND TOTAL ^a	4,200	31,200	195,900	30,600	14,700

N = Negligible

a = Totals have been rounded.

TABLE 26 SUMMARY OF AIR POLLUTANT EMISSIONS IN ROWAN COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	240	490	39,200	3,280	2,510
Other	20	60	30	70	120
Subtotal	260	550	39,230	3,350	3,630
Stationary Fuel Combustion					
Industry	1,700	3,930	110	40	1,300
Steam-Electric	23,300	73,000	310	120	12,300
Residential	260	90	220	50	100
Commercial and Institutional	300	540	300	60	100
Subtotal	25,560	77,560	940	270	13,800
Refuse Disposal					
Incineration	10	70	300	N	20
Open Burning	30	440	2,370	830	300
Subtotal	40	510	2,670	830	320
Industrial Processes	--	4,380	--	--	--
Evaporative Losses	--	--	--	3,300	--
GRAND TOTALS ^a	25,900	83,000	42,800	7,800	16,800

N = Negligible

a = Totals have been rounded.

TABLE 27 SUMMARY OF AIR POLLUTANT EMISSIONS IN UNION COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	140	270	20,700	1,760	1,390
Other	10	30	20	40	70
Subtotal	150	300	20,720	1,800	1,460
Stationary Fuel Combustion					
Industry	170	60	N	N	160
Steam-Electric	--	--	--	--	--
Residential	110	40	80	20	40
Commercial and Institutional	80	50	80	20	50
Subtotal	360	150	160	40	250
Refuse Disposal					
Incineration	10	50	200	N	10
Open Burning	N	80	420	150	50
Subtotal	10	130	620	150	60
Industrial Processes	--	19,600	460	40	--
Evaporative Losses	--	--	--	1,820	--
GRAND TOTAL ^a	500	20,200	22,000	3,800	1,800

N = Negligible

a = Total have been rounded.

TABLE 28 SUMMARY OF AIR POLLUTANT EMISSIONS IN CHESTER COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	80	160	11,200	970	800
Other	10	20	10	30	40
Subtotal	90	180	11,210	1,000	840
Stationary Fuel Combustion					
Industry	120	30	N	N	140
Steam-Electric	--	--	--	--	--
Residential	50	20	60	10	30
Commercial and Institutional	40	20	20	N	10
Subtotal	210	70	80	10	180
Refuse Disposal					
Incineration	N	30	130	N	10
Open Burning	10	110	590	210	80
Subtotal	10	140	720	210	90'
Industrial Processes	--	--	--	--	--
Evaporative Losses	--	--	--	1,070	--
GRAND TOTAL ^a	300	400	12,000	2,300	1,100

N = Negligible

a = Totals have been rounded.

TABLE 29 SUMMARY OF AIR POLLUTANT EMISSIONS IN LANCASTER COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	130	260	20,500	1,740	1,350
Other	10	30	10	40	60
Subtotal	140	290	20,510	1,780	1,410
Stationary Fuel Combustion					
Industry	2,700	10,700	200	70	1,510
Steam-Electric	--	--	--	--	--
Residential	90	30	90	20	40
Commercial and Institutional	70	50	80	10	10
Subtotal	2,860	10,780	370	100	1,560
Refuse Disposal					
Incineration	10	40	180	N	10
Open Burning	20	350	1,860	660	240
Subtotal	30	390	2,040	660	250
Industrial Processes	--	1,300	5,620	--	--
Evaporative Losses	--	--	--	1,750	--
GRAND TOTAL ^a	3,000	12,800	28,500	4,300	3,200

N = Negligible

a = Totals have been rounded.

TABLE 30 SUMMARY OF AIR POLLUTANT EMISSIONS IN YORK COUNTY, 1968
(Tons/Year)

Source Category	Sulfur Oxides	Partic- ulates	Carbon Monoxide	Hydro- carbons	Nitrogen Oxides
Transportation					
Motor Vehicles	190	370	29,400	2,500	1,940
Other	20	60	30	70	120
Subtotal	210	430	29,430	2,570	2,060
Stationary Fuel Combustion					
Industry	5,500	3,830	390	130	5,680
Steam-Electric	--	--	--	--	--
Residential	60	30	N	10	80
Commercial and Institutional	90	50	80	20	20
Subtotal	5,650	3,910	470	160	5,780
Refuse Disposal					
Incineration	10	80	340	10	20
Open Burning	30	420	2,210	780	290
Subtotal	40	500	2,550	790	310
Industrial Processes	270	9,200	740	170	1,350
Evaporative Losses	--	--	--	2,720	--
GRAND TOTAL ^a	6,200	14,000	33,200	6,400	9,500

N = Negligible

a = Totals have been rounded.

EMISSIONS BY GRID

For the purpose of defining the geographical variation of air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid coordinate system. The emissions were divided into two source groups--point and area sources. Seventy-one point sources are identified individually with respect to location and emissions. Each of these point sources emitted more than 0.5 tons per average annual day of any pollutant.

CONTRIBUTIONS OF POINT AND AREA SOURCES

Figure 5 shows the location of all point sources in the area. Collectively the seventy-one point sources account for 64 percent of the sulfur oxides, 94 percent of the particulates, 70 percent of the nitrogen oxides, and only 4 percent of the carbon monoxide and 4 percent of the hydrocarbons. The percentage contribution to carbon monoxide emissions is low because motor vehicles, which are area sources, contribute 93 percent of the total carbon monoxide emissions. Similarly, the contribution to total hydrocarbon emissions is low since two groups of area sources, motor vehicles and evaporative losses are the major sources. Table 31 presents the emissions of point sources. Each source is identified by source category, grid number and horizontal and vertical coordinates. The emissions of sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides are shown for an average annual day, average winter day (December, January, February), and average summer day (June, July, August). The appendix presents the method of calculating these three averages.

Area sources are sources of emissions that are significant by themselves, but as a group may emit a large portion of the areas total pollution. Examples of area sources are motor vehicles, residences, light commercial and industrial establishments and backyard burning. The emissions from area sources have been added to that for point sources to obtain total emissions from all sources by grid, as shown in Table 32. The emissions from all sources are also shown for an annual average, winter and summer day.

TABLE 31 (cont.)

ID GRID	HC	VC	S	W	A	S	W	A	S	W	A	S	W	A
2 35	5350	39270	1.9	3.9	2.7	5.17	10.71	7.39	0.13	0.28	0.19	0.04	0.09	0.06
2 37	5380	39170	0.3	0.6	0.4	0.68	1.40	0.97	0.02	0.05	0.03	0.00	0.01	0.01
4 39	4310	39010	42.5	42.5	34.9	111.13	111.13	91.34	0.50	0.50	0.41	0.20	0.20	0.16
2 41	4580	39020	0.1	0.2	0.1	0.36	0.76	0.52	0.00	0.01	0.01	0.00	0.00	0.00
2 41	4580	39020	0.0	0.0	0.0	3.41	3.41	3.41	0.00	0.00	0.00	0.00	0.00	0.00
2 42	4710	39040	0.1	0.2	0.1	2.82	2.84	2.83	0.00	0.00	0.00	0.00	0.00	0.00
2 42	4620	38970	0.2	0.4	0.3	0.77	1.60	1.10	0.01	0.03	0.02	0.00	0.01	0.00
2 42	4680	38970	0.0	0.0	0.0	12.29	12.29	12.29	0.00	0.00	0.00	0.00	0.00	0.00
2 43	4870	39040	0.1	0.3	0.2	0.61	1.27	0.87	0.01	0.02	0.02	0.00	0.00	0.00
2 45	4970	39060	0.2	0.5	0.3	0.79	1.63	1.13	0.01	0.03	0.02	0.00	0.01	0.00
2 45	4975	39065	0.0	0.0	0.0	0.55	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00
7 48	5140	39080	0.0	0.0	0.0	0.00	0.00	0.00	1.76	1.76	1.76	0.34	0.34	0.34
2 54	5110	39030	0.0	0.0	0.0	14.00	14.00	14.00	0.00	0.00	0.00	0.00	0.00	0.00
2 54	5130	39040	0.0	0.0	0.0	19.00	19.00	19.00	0.00	0.00	0.00	0.00	0.00	0.00
2 57	4920	38980	1.5	3.2	2.2	2.18	4.52	3.12	0.05	0.10	0.07	0.01	0.03	0.02
7 60	5060	38980	0.0	0.0	0.0	0.62	0.62	0.62	14.24	14.24	14.24	2.93	2.93	2.93
7 60	5090	38990	0.0	0.0	0.0	0.00	0.00	0.00	1.83	1.83	1.83	0.35	0.35	0.35
2 61	5140	38980	0.0	0.0	0.0	2.10	2.10	2.10	0.00	0.00	0.00	0.00	0.00	0.00
2 61	5140	38960	0.0	0.0	0.0	0.74	0.76	0.75	0.00	0.00	0.00	0.00	0.00	0.00
2 61	5130	38960	0.0	0.0	0.0	0.79	0.79	0.79	1.58	1.58	1.58	0.00	0.00	0.00
2 62	5170	38985	0.1	0.3	0.2	0.58	1.21	0.83	0.01	0.03	0.02	0.00	0.01	0.00
2 62	5170	38990	0.1	0.3	0.2	0.49	1.01	0.70	0.01	0.02	0.01	0.00	0.00	0.00
2 62	5170	38995	0.1	0.3	0.2	0.58	1.20	0.83	0.01	0.02	0.01	0.00	0.00	0.00
2 62	5160	38990	0.0	0.0	0.0	2.10	2.11	2.10	0.00	0.00	0.00	0.00	0.00	0.00
4 64	4980	38960	203.3	203.3	167.0	96.98	96.98	79.71	2.67	2.67	2.19	1.07	1.07	0.88
2 69	5240	39090	0.0	0.0	0.0	9.99	9.99	9.99	0.00	0.00	0.00	0.00	0.00	0.00
7 69	5250	38970	0.0	0.0	0.0	0.00	0.00	0.00	0.25	0.25	0.25	0.04	0.04	0.04
5 71	4780	38830	0.0	0.0	0.0	0.19	0.19	0.19	1.04	1.04	1.04	0.36	0.36	0.36
5 71	4790	38720	0.0	0.0	0.0	0.25	0.25	0.25	1.35	1.35	1.35	0.47	0.47	0.47



TABLE 31 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES IN THE CHARLOTTE STUDY AREA, 1968
TONS/DAY

ID	GRIDHC	VC	SOX			PART			CO			HC			NOX		
			S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
2	1 5198	39740	0.0	0.0	0.0	0.64	0.64	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	4 4690	39520	0.1	0.3	0.2	0.49	1.03	0.71	0.01	0.02	0.01	0.00	0.00	0.00	0.07	0.15	0.10
2	5 4750	39540	0.0	0.0	0.0	6.84	6.84	6.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5 4760	39540	0.0	0.0	0.0	1.25	1.25	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	9 5080	39580	0.0	0.0	0.0	0.82	0.82	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	9 5090	39590	0.0	0.0	0.0	3.39	3.39	3.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	10 5108	39580	0.0	0.0	0.0	1.99	1.99	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	11 5310	39520	0.1	0.3	0.2	0.07	0.16	0.11	0.01	0.02	0.01	0.01	0.02	0.01	0.37	0.78	0.54
2	12 5440	39550	0.0	0.0	0.0	9.99	9.99	9.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	13 5520	39510	1.3	2.7	1.9	4.55	9.43	6.50	0.10	0.22	0.15	0.03	0.07	0.05	0.73	1.52	1.05
4	13 5520	39520	77.8	77.8	63.9	243.34	243.34	200.00	1.02	1.02	0.84	0.41	0.41	0.33	41.01	41.01	33.70
5	13 5510	39502	0.0	0.0	0.0	0.36	0.36	0.36	1.95	1.95	1.95	0.69	0.69	0.69	0.25	0.25	0.25
2	21 5470	39460	0.3	0.6	0.4	1.04	2.15	1.49	0.02	0.05	0.03	0.00	0.01	0.01	0.16	0.33	0.23
2	21 5490	39470	0.1	0.2	0.1	0.42	0.88	0.61	0.01	0.02	0.01	0.00	0.00	0.00	0.06	0.13	0.09
5	21 5460	39470	0.3	0.3	0.3	0.97	0.97	0.97	0.46	0.46	0.46	0.09	0.09	0.09	0.07	0.07	0.07
5	22 5530	39490	0.0	0.0	0.0	0.28	0.28	0.28	1.48	1.48	1.48	0.52	0.52	0.52	0.19	0.19	0.19
4	23 5030	39380	140.3	140.3	115.3	108.14	108.14	88.88	1.84	1.84	1.51	0.73	0.73	0.60	73.90	73.90	60.74
2	24 5170	39370	0.0	0.0	0.0	0.58	0.58	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	26 5380	39380	0.0	0.0	0.0	1.99	1.99	1.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	26 5360	39370	0.0	0.0	0.0	0.19	0.19	0.19	1.01	1.01	1.01	0.35	0.35	0.35	0.13	0.13	0.13
5	26 5340	39330	0.0	0.0	0.0	0.10	0.10	0.10	0.53	0.53	0.53	0.18	0.18	0.18	0.06	0.06	0.06
5	28 5530	39350	0.0	0.0	0.0	0.11	0.11	0.11	0.60	0.60	0.60	0.21	0.21	0.21	0.07	0.07	0.07
2	30 4490	39180	0.1	0.2	0.1	0.46	0.95	0.65	0.01	0.02	0.01	0.00	0.00	0.00	0.07	0.14	0.10
2	31 4710	39200	0.0	0.0	0.0	15.49	15.49	15.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	31 4030	39120	109.0	109.0	89.6	260.40	260.40	214.1	1.43	1.43	1.17	0.57	0.57	0.47	57.52	57.52	47.28

TABLE 31 (cont.)

ID	GRID	HC	VC	S	W	A	S	W	A	S	W	A	S	W	A
2	73	5010	38580	0.0	0.0	0.0	20.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00
5	73	5040	38730	0.0	0.0	0.0	0.10	0.10	0.10	0.57	0.57	0.57	0.20	0.20	0.07
2	75	5407	38730	0.0	0.0	0.0	0.88	0.88	0.88	0.00	0.00	0.00	0.00	0.00	0.00
2	75	5580	38720	0.0	0.0	0.0	0.20	0.20	0.20	1.24	1.24	1.24	0.10	0.10	0.00
2	75	5405	38710	0.0	0.0	0.0	52.49	52.49	52.49	0.00	0.00	0.00	0.00	0.00	0.00
2	78	4980	38630	0.2	0.5	0.3	1.17	2.42	1.67	0.02	0.04	0.03	0.00	0.01	0.01
2	78	4960	38660	3.7	4.8	4.2	1.59	2.03	1.77	0.29	0.38	0.33	0.09	0.12	0.11
2	81	5010	38690	6.4	8.2	7.1	3.12	3.98	3.46	0.51	0.62	0.57	0.17	0.21	0.18
2	81	5080	38530	2.4	3.1	2.7	25.61	25.88	25.72	0.76	0.77	0.76	0.38	0.39	0.38
2	81	5070	38530	0.0	0.0	0.0	0.20	0.20	0.20	1.27	1.27	1.27	0.10	0.10	0.10
5	85	4810	38380	0.0	0.0	0.0	0.09	0.09	0.09	0.51	0.51	0.51	0.18	0.18	0.18
2	86	5190	38400	4.2	5.8	6.1	18.08	37.42	25.83	0.33	0.70	0.48	0.11	0.23	0.16
2	86	5140	38410	0.0	0.0	0.0	2.50	2.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00
5	86	5180	38380	0.0	0.0	0.0	0.14	0.14	0.14	0.75	0.75	0.75	0.26	0.26	0.26
2	87	5220	38410	0.4	0.9	0.6	1.90	3.93	2.71	0.03	0.07	0.05	0.01	0.02	0.01
2	87	5210	38390	0.0	0.0	0.0	1.04	1.04	1.04	15.39	15.39	15.39	0.00	0.00	0.00
5	87	5210	38420	0.0	0.0	0.0	0.10	0.10	0.10	0.58	0.58	0.58	0.20	0.20	0.20

ID KEY

2 = Industrial

4 = Steam-Electric Utility

5 = Dump

7 = Airport

TABLE 32 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES IN THE CHARLOTTE STUDY AREA, 1968
TONS/DAY

GRID AREA	(SQ. MI.)	SOX			PART			CO			HC			NOX		
		S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
1	154.4	0.2	0.5	0.3	0.9	1.0	0.9	9.3	7.6	8.6	1.9	1.7	1.8	1.0	1.1	1.0
2	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	38.6	0.0	0.1	0.1	0.1	0.1	0.1	1.7	1.5	1.6	0.3	0.3	0.3	0.2	0.2	0.2
4	38.6	0.7	1.6	1.1	1.5	2.4	1.9	45.3	37.7	41.5	6.8	6.0	6.4	3.1	3.2	3.1
5	38.6	0.4	0.8	0.6	8.8	9.0	8.9	24.5	20.4	22.5	4.1	3.6	3.8	1.9	1.9	1.9
6	154.4	0.3	0.6	0.4	0.4	0.6	0.5	14.7	12.3	13.5	2.8	2.4	2.6	1.4	1.4	1.4
7	38.6	0.1	0.3	0.2	0.2	0.3	0.2	8.6	7.2	7.9	1.5	1.3	1.4	0.7	0.8	0.7
8	38.6	0.1	0.3	0.2	0.2	0.2	0.2	7.4	6.2	6.8	1.3	1.1	1.2	0.6	0.6	0.6
9	38.6	0.3	0.7	0.4	4.6	4.8	4.7	17.9	15.0	16.4	3.0	2.7	2.9	1.5	1.6	1.5
10	38.6	0.3	0.7	0.5	2.4	2.6	2.5	18.8	15.8	17.3	3.2	2.8	3.0	1.6	1.7	1.6
11	154.4	0.3	0.7	0.5	0.4	0.6	0.4	8.0	6.8	7.4	1.5	1.4	1.5	1.1	1.6	1.3
12	38.6	0.1	0.2	0.1	10.1	10.1	10.1	3.5	3.0	3.2	0.6	0.5	0.6	0.3	0.3	0.3
13	38.6	79.2	80.7	66.0	248.3	253.2	206.9	5.0	4.8	4.7	1.5	1.5	1.4	42.2	43.0	35.2
14	154.4	0.1	0.3	0.2	0.1	0.2	0.2	3.5	3.0	3.2	0.7	0.7	0.7	0.3	0.4	0.4
15	154.4	0.4	0.9	0.6	0.6	0.8	0.6	20.1	16.8	18.5	3.7	3.3	3.5	1.8	1.9	1.8
16	154.4	0.4	1.0	0.6	0.7	0.9	0.8	23.3	19.5	21.4	4.3	3.8	4.1	2.1	2.2	2.1
17	38.6	0.0	0.1	0.1	0.1	0.1	0.1	2.1	1.8	2.0	0.4	0.3	0.4	0.2	0.2	0.2
18	38.6	0.1	0.2	0.1	0.1	0.2	0.1	4.6	3.8	4.2	0.9	0.8	0.8	0.4	0.5	0.5
19	38.6	0.1	0.1	0.1	0.1	0.1	0.1	2.6	2.2	2.4	0.5	0.4	0.5	0.2	0.3	0.2
20	38.6	0.0	0.1	0.1	0.1	0.1	0.1	1.7	1.4	1.6	0.3	0.3	0.3	0.2	0.2	0.2
21	38.6	2.0	4.0	2.8	4.6	7.6	5.8	54.7	46.1	50.3	9.5	7.5	8.0	4.1	4.6	4.3
22	38.6	0.2	0.5	0.3	0.6	0.7	0.6	13.7	11.6	12.6	2.4	2.2	2.3	1.0	1.1	1.0
23	38.6	140.4	140.4	115.4	108.2	108.2	88.9	2.5	2.4	2.1	0.9	0.8	0.7	74.0	74.0	60.8
24	38.6	0.3	0.7	0.4	1.0	1.1	1.0	14.5	12.2	13.3	2.7	2.4	2.6	1.4	1.5	1.4
25	38.6	0.1	0.4	0.2	0.2	0.2	0.2	6.9	5.8	6.3	1.3	1.1	1.2	0.6	0.7	0.6

Reproduced from
best available copy.

TABLE 32 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES (cont.)

GRID	AREA	SOx	PART	CO	HC	NOx
26	38.6	0.6	3.3	3.5	23.3	2.3
27	38.6	0.1	0.1	4.8	4.0	0.3
28	38.6	0.1	0.2	4.6	3.9	0.4
29	154.4	0.1	0.1	2.3	2.0	0.2
30	154.4	0.5	1.0	5.3	5.1	1.5
31	154.4	0.6	16.5	44.4	37.4	7.2
32	154.4	0.4	1.2	22.7	18.8	3.4
33	154.4	109.5	260.8	11.2	9.7	2.4
34	38.6	0.1	0.2	8.0	6.8	1.3
35	38.6	2.5	6.2	48.9	41.6	7.3
36	38.6	0.1	0.1	6.1	5.1	1.1
37	38.6	1.3	2.8	30.4	26.0	5.0
38	154.4	0.3	0.4	16.8	14.4	3.0
39	38.6	42.6	111.3	1.0	1.1	0.4
40	38.6	0.1	0.1	0.3	0.4	0.2
41	154.4	1.1	5.6	6.3	7.1	2.8
42	154.4	0.9	17.1	20.0	17.6	4.1
43	38.6	1.4	2.1	73.6	61.9	11.6
44	9.6	0.0	0.1	2.2	1.9	0.5
45	9.6	0.4	1.6	10.9	9.2	1.8
46	9.6	0.1	0.3	4.4	3.7	0.7
47	9.6	0.1	0.1	7.9	6.5	1.1
48	9.6	0.0	0.1	6.5	5.7	1.1
49	9.6	0.1	0.1	8.4	6.9	1.2
50	9.6	0.4	0.4	22.4	18.7	3.6
51	9.6	0.2	0.5	26.8	22.4	4.3
52	9.6	0.2	0.3	22.3	18.3	3.1
53	9.6	0.4	0.6	27.9	23.1	4.3
54	9.6	0.5	33.8	43.1	36.0	6.7

GRID	AREA 9.6	TABLE 32 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES (cont.)														
		SO ₂ 0.4	SO _x 0.6	CO 1.0	PM ₁₀ 1.2	PM _{2.5} 1.1	CO 39.8	CO 33.0	HC 36.3	HC 6.2	HC 5.3	HC 5.7	NO _x 3.3	NO _x 3.7	NO _x 3.4	
56	38.6	0.1	0.7	0.3	0.3	0.6	0.4	1.9	2.3	2.0	1.4	1.6	1.5	0.5	1.0	0.7
57	9.6	1.6	3.5	2.4	2.3	4.7	3.3	3.0	2.8	2.9	0.7	0.7	0.7	0.7	1.3	0.9
58	9.6	0.0	0.3	0.1	0.1	0.2	0.2	1.4	1.4	1.4	0.6	0.7	0.7	0.2	0.4	0.3
59	9.6	0.0	0.1	0.0	0.1	0.1	0.1	3.7	3.0	3.3	0.6	0.5	0.5	0.3	0.3	0.3
60	9.6	0.3	0.8	0.5	1.2	1.4	1.3	40.7	36.6	38.6	7.1	6.6	6.8	2.8	3.0	2.8
61	9.6	1.6	4.2	2.6	5.7	7.1	6.3	125.6	104.8	115.0	16.5	14.5	15.5	7.1	8.8	7.7
62	9.6	1.4	3.9	2.4	5.9	9.2	7.2	87.0	72.8	79.8	12.1	10.7	11.4	4.5	5.9	5.0
63	9.6	0.0	0.1	0.0	0.0	0.0	0.0	0.8	0.7	0.7	0.2	0.2	0.2	0.1	0.1	0.1
64	9.6	203.2	203.4	167.1	97.0	97.0	79.7	2.8	2.8	2.3	1.2	1.2	1.0	****	****	88.0
65	9.6	0.0	0.0	0.0	0.0	0.0	0.0	3.4	2.8	3.1	0.5	0.4	0.4	0.2	0.2	0.2
66	9.6	0.2	0.4	0.3	0.2	0.3	0.3	10.2	8.5	9.3	1.5	1.3	1.4	0.8	0.9	0.8
67	9.6	0.4	1.6	0.9	1.1	2.1	1.5	33.9	28.6	31.1	5.8	5.2	5.5	2.3	2.9	2.5
68	9.6	0.3	1.0	0.6	0.9	1.5	1.1	24.0	20.2	22.0	3.9	3.5	3.7	1.6	1.9	1.7
69	154.4	0.5	1.6	0.9	10.9	11.4	11.1	50.4	42.3	46.3	8.6	7.6	8.1	3.8	4.1	3.8
70	154.4	0.1	0.2	0.1	0.1	0.2	0.1	4.1	3.5	3.8	0.8	0.7	0.7	0.3	0.4	0.3
71	154.4	0.4	0.8	0.5	1.4	2.0	1.7	12.7	11.1	11.9	3.2	3.0	3.1	1.4	1.6	1.5
72	154.4	0.2	0.5	0.3	0.5	0.7	0.6	10.7	9.0	9.8	2.2	2.0	2.1	1.0	1.0	1.0
73	154.4	0.6	1.4	0.9	21.5	22.2	21.8	40.7	33.9	37.2	7.2	6.2	6.7	3.6	3.7	3.6
74	154.4	0.3	0.7	0.5	0.5	0.6	0.5	24.3	20.3	22.3	4.2	3.7	3.9	1.9	1.9	1.8
75	154.4	0.4	0.9	0.6	54.2	54.4	54.3	27.4	23.3	25.3	4.7	4.2	4.4	2.1	2.1	2.1
76	154.4	0.1	0.2	0.1	0.2	0.3	0.2	3.2	2.7	2.9	0.7	0.7	0.7	0.3	0.3	0.3
77	38.6	0.0	0.1	0.0	0.1	0.1	0.1	2.0	1.6	1.8	0.4	0.3	0.3	0.1	0.1	0.1
78	38.6	4.9	7.0	5.7	4.8	7.6	5.9	42.9	35.9	39.4	7.3	6.5	6.9	5.1	5.9	5.4
79	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.4	0.5	0.1	0.1	0.1	0.0	0.0	0.0
80	38.6	0.1	0.1	0.1	0.2	0.2	0.2	3.1	2.6	2.9	0.6	0.6	0.6	0.2	0.2	0.2
81	154.4	9.0	11.7	10.1	29.3	30.4	29.7	19.5	16.7	18.1	3.2	2.9	3.0	15.7	19.5	17.2
82	154.4	0.2	0.5	0.3	0.3	0.4	0.4	14.1	11.9	12.9	2.4	2.2	2.3	1.1	1.0	1.0
83	154.4	0.1	0.4	0.2	0.2	0.3	0.3	11.1	9.3	10.2	1.9	1.7	1.8	0.8	0.8	0.8

GRID AREA	TABLE 32		SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES (cont.)									
	SOM	0.2	0.2	0.2	0.2	0.2	CO	5.7	1.2	HC	1.1	NOx
84 154.4	0.1	0.3	0.2	0.2	0.2	0.2	5.3	5.7	1.2	1.1	1.1	0.6 0.6 0.6
85 154.4	0.5	1.0	0.7	1.1	1.9	1.4	17.5	14.8	16.1	3.2	2.8	1.6 1.7 1.6
86 154.4	4.6	9.5	6.5	21.2	40.7	29.0	22.0	19.0	20.4	3.8	3.5	4.0 6.6 5.0
87 154.4	0.8	1.8	1.2	3.8	6.0	4.7	42.4	38.3	40.3	4.9	4.4	2.3 2.4 2.3
88 154.4	0.0	0.1	0.1	0.1	0.1	0.1	3.1	2.7	2.9	0.6	0.5	0.3 0.2 0.3
89 154.4	0.0	0.1	0.0	0.0	0.0	0.0	1.5	1.2	1.3	0.3	0.2	0.1 0.1 0.1
90 154.4	0.0	0.1	0.1	0.1	0.1	0.1	2.3	1.9	2.1	0.4	0.4	0.2 0.2 0.2
91 154.4	0.1	0.3	0.2	0.2	0.2	0.2	6.3	5.3	5.8	1.2	1.1	0.6 0.7 0.7
92 154.4	0.1	0.2	0.2	0.3	0.4	0.4	6.8	5.9	6.3	1.5	1.3	0.7 0.7 0.6

EMISSION DENSITIES

In order to provide a visual representation of the emissions of pollutants by grids, emission density maps have been prepared. Emission densities were obtained by summing the annual area and point source emissions for each grid and dividing this total by the land area of the grid. Figures 6 through 10 show the variation in emission densities for the respective grids throughout the Study Area. As expected the emissions generally follow the pattern and degree of urbanization. Emission densities for carbon monoxide and hydrocarbons are higher in the grids with the higher populations and corresponding higher vehicular activity. Sulfur oxides, particulates and nitrogen oxide emission densities are highest in the grids where power plants are located. Particulate emissions tend to follow the general pattern of the location of industrial and other sources as shown in Figure 5.

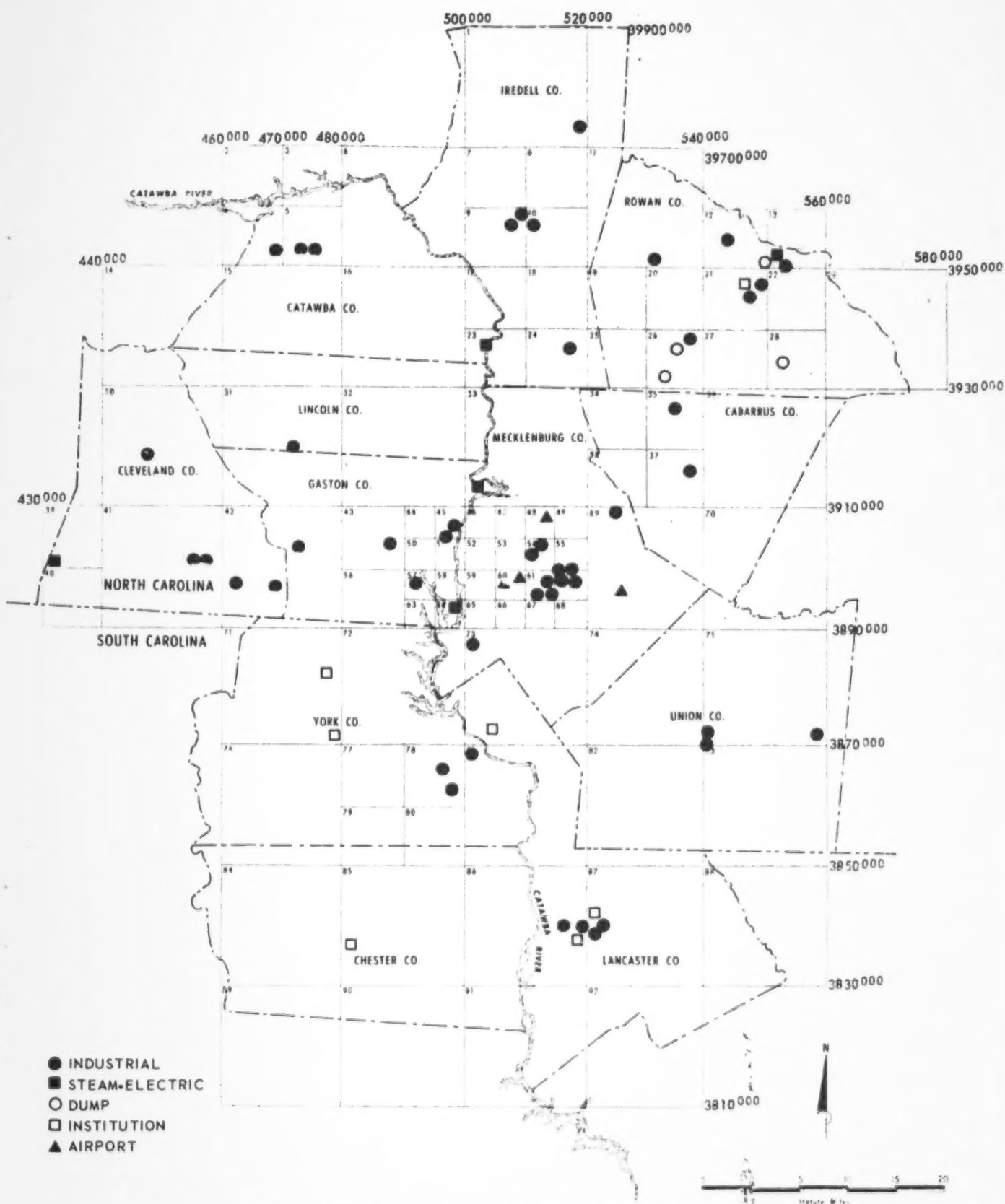


Figure 5. Point source locations for Charlotte study area.

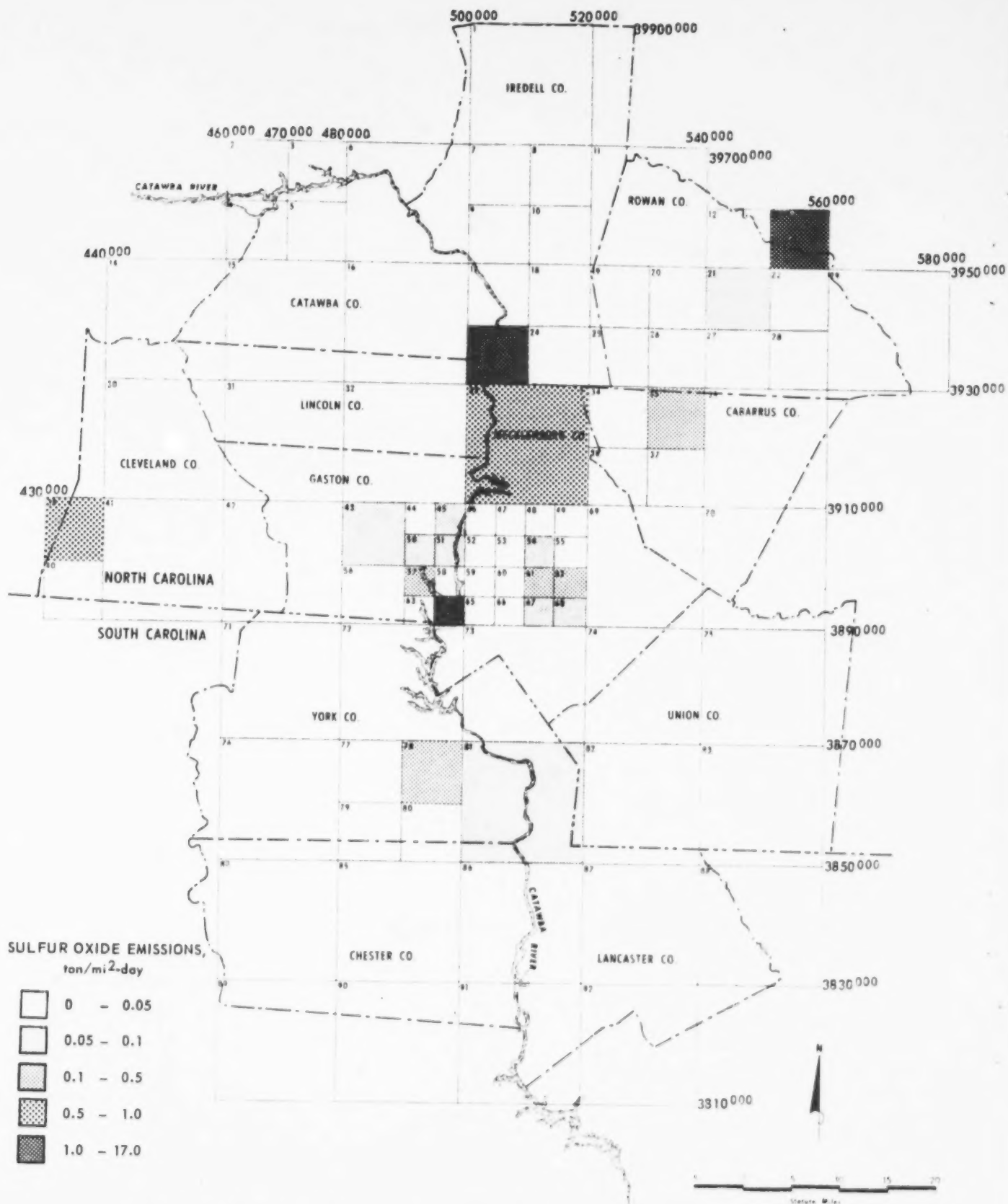


Figure 6. Sulfur oxide emission density from all sources in the Charlotte study area.

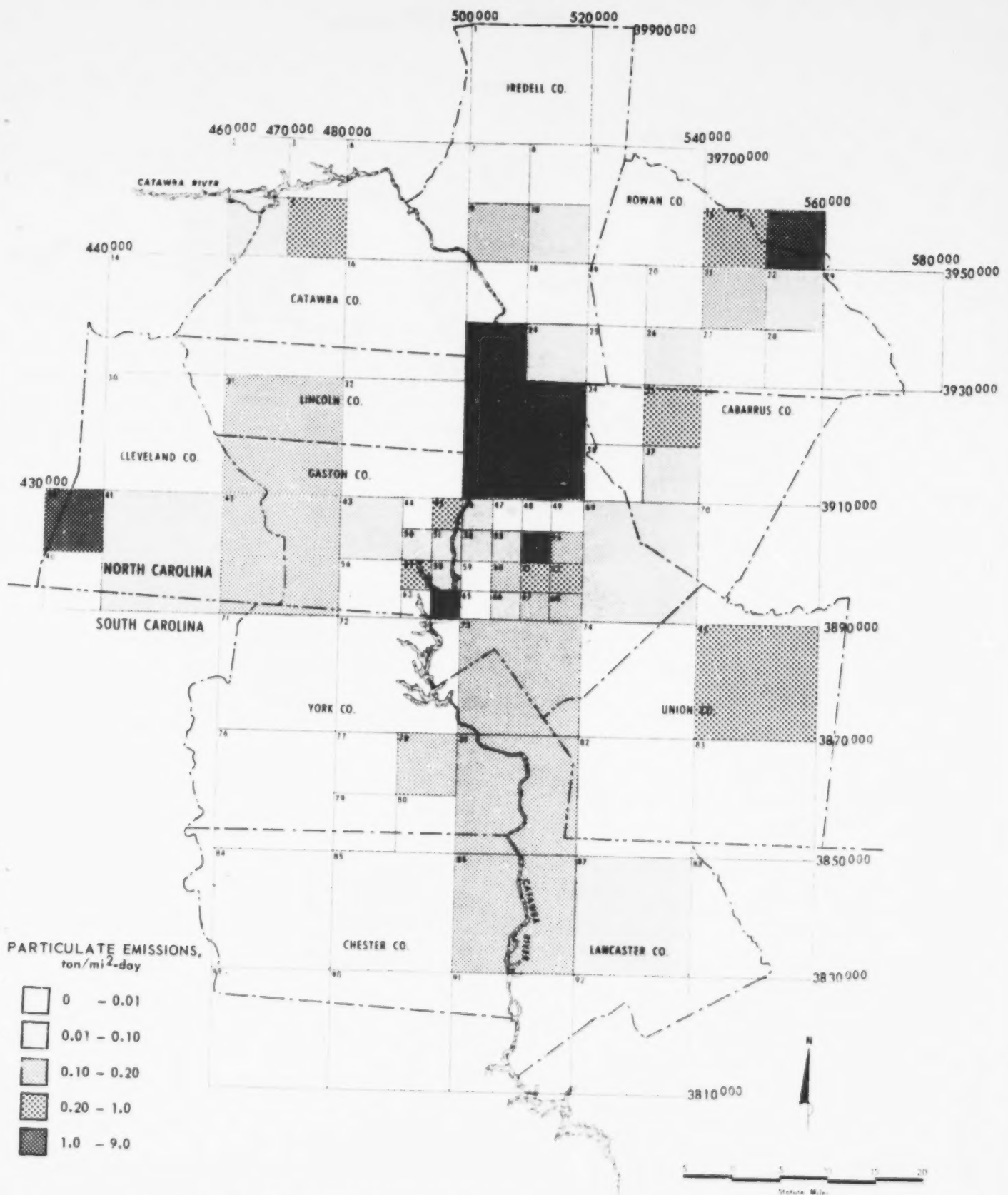


Figure 7. Particulate emission density from all sources in the Charlotte study area.

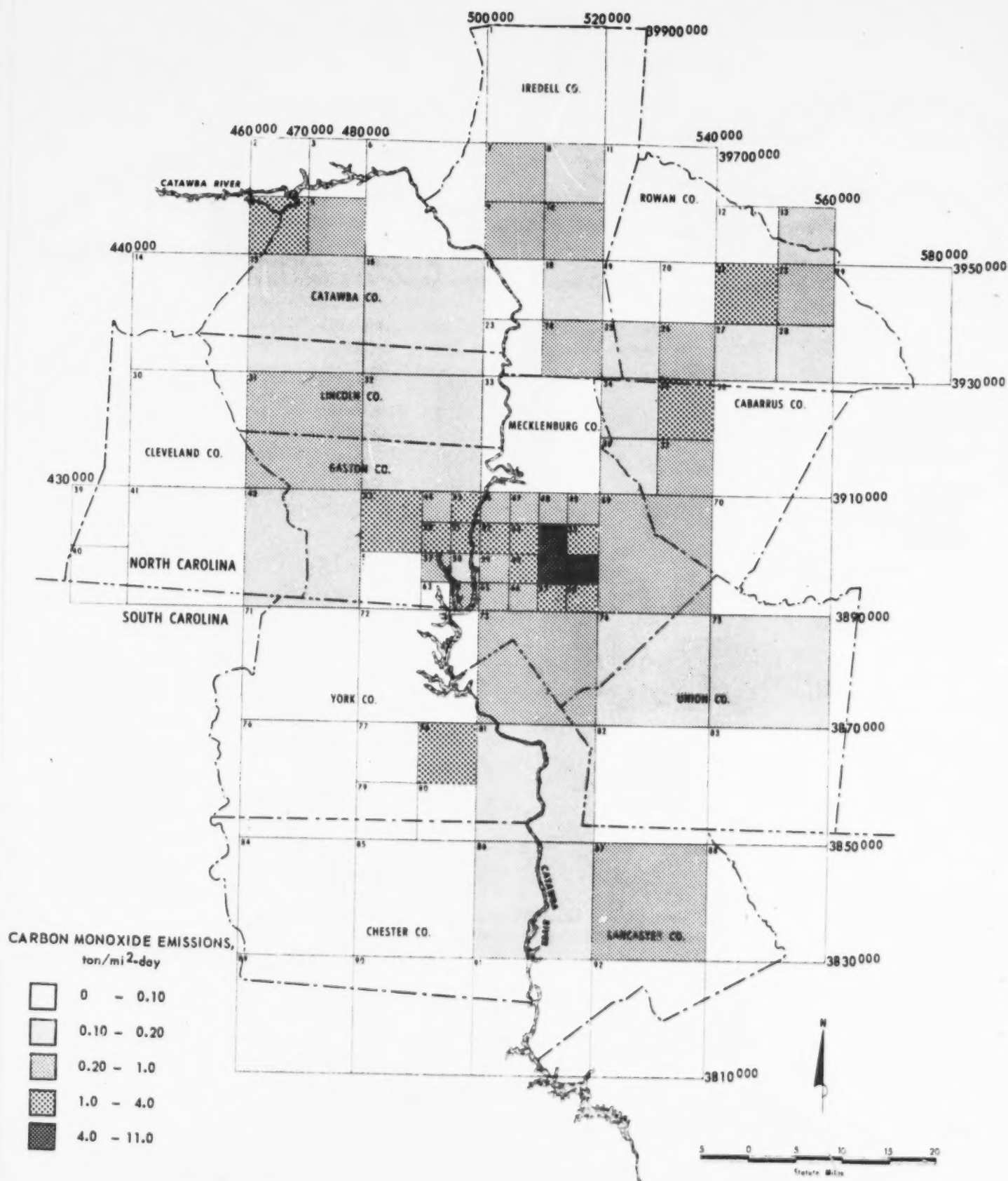


Figure 8. Carbon monoxide emission density from all sources in the Charlotte study area.

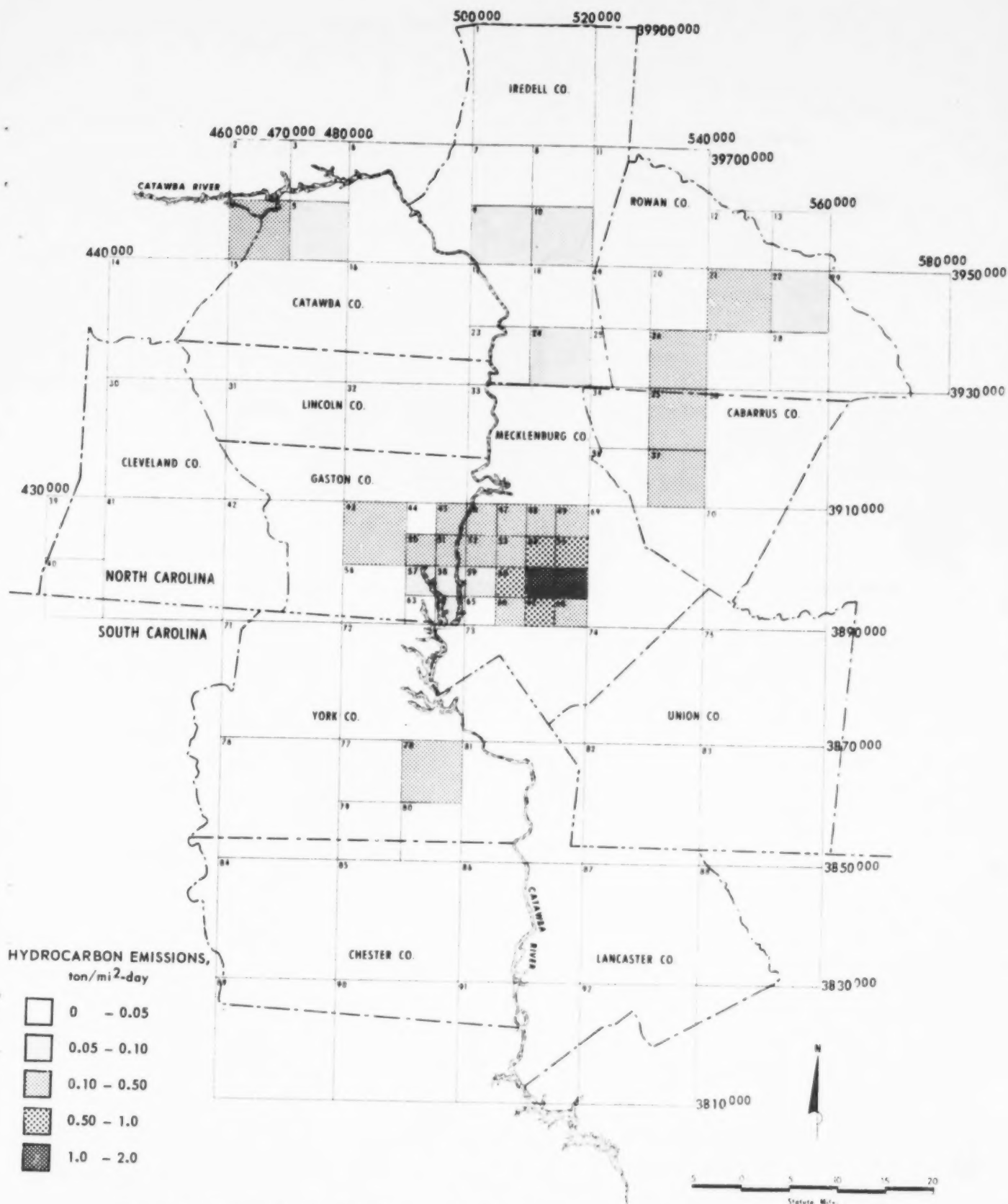


Figure 9. Hydrocarbon emission density from all sources in the Charlotte study area.

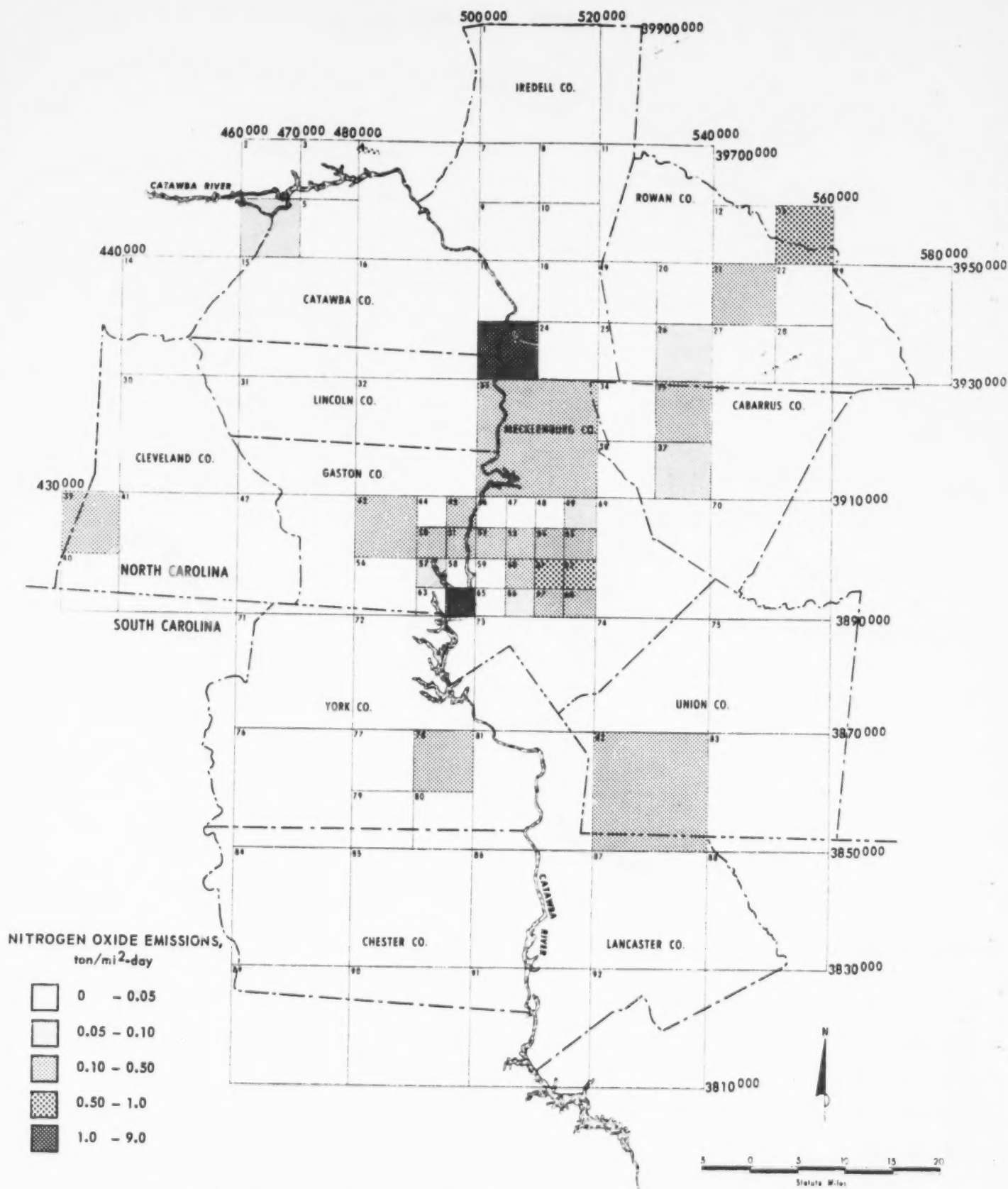


Figure 10. Nitrogen oxide emission density from all sources in the Charlotte study area.

REFERENCES

1. Ozolins, Guntis and Raymond Smith, Rapid Survey Techniques for Estimating Community Air Pollution Emissions. DHEW, PHS, October 1966.
2. Duprey, R. L., Compilation of Air Pollutant Emission Factors, United States, DHEW, PHS, 1968.
3. Population Estimates, State of South Carolina Auditors Office and the State of North Carolina Department of Water and Air Resources.
4. Local Climatological Data, United States Department of Commerce, 1968.
5. North Carolina Directory of Manufacturing Firms, 1968. North Carolina Department of Labor.
6. Thirty-Third Annual Report of the Department of Labor of the State of South Carolina, 1968.
7. Steam Electric Plant Factors, National Coal Association, 1969.
8. Ozolins, op. cit., pp. 43-45.
9. Retail Trade Special Report, Census of Business, United States Department of Commerce, Bureau of the Census, 1963.
10. Highway Statistics/1967, United States Department of Transportation, Federal Highway Administration, Bureau of Public Roads.
11. Duprey, op. cit., p. 46.
12. St. Louis Interstate Air Pollution Study, Phase II, Air Pollutant Emission Inventory, 1966, p. 38.

APPENDIX A
METHOD FOR CALCULATING SUMMER, WINTER AND ANNUAL
AVERAGE EMISSIONS FOR FUEL CONSUMPTION IN STATIONARY SOURCES

YEARLY AVERAGE (A)

$$A = \frac{\text{Fuel Consumed} \times \text{Emission Factor (E. F.)}}{\text{Days of Operation}}$$

e.g. A plant consumed 100,000 tons of coal in 1967 while operating 365 days. The total degree days for the area was 4,800 and 2,800 for the three winter months. The plant was estimated to use 15 percent of the fuel for space heating and 85 percent for process heating. From this information, the annual average emission for carbon monoxide would be the following:

$$A = \frac{100,000 \text{ Tons/year} \times 3 \text{ lbs. CO/Ton coal}}{365 \text{ Days/year} \times 2,000 \text{ lb./Ton}}$$

$$A = 0.41 \text{ Ton/Day}$$

WINTER AVERAGE (W)

$$W = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Winter Operation}} \times \frac{\text{Winter Degree Days}}{\text{Total Degree Days}} \times \begin{matrix} \% \text{ Fuel Used} \\ \text{for space heating} \end{matrix}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \% \text{ Fuel used for process heating}$$

$$W = \left[\frac{100,000 \times 2,800}{90 \times 4,800} \times 0.15 + \frac{100,000}{365} \times 0.85 \right] \frac{3}{2,000}$$

$$W = 0.49 \text{ Ton/Day}$$

SUMMER AVERAGE (S)

$$S = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Summer Operation}} \times \frac{\text{Summer Degree Days}}{\text{Total Degree Days}} \times \begin{matrix} \% \text{ Fuel Used} \\ \text{for space heating} \end{matrix}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \% \text{ Fuel used for process heating}$$

$$S = \left[\frac{100,000}{90} \times \frac{0}{4,800} \times 0.15 + \frac{100,000}{365} \times 0.85 \right] \frac{3}{2,000}$$

$$S = 0.35 \text{ Ton/Day}$$

APPENDIX B
METRIC CONVERSION FACTORS

<u>Multiply</u>	<u>By.</u>	<u>To Obtain</u>
Feet	0.3048	Meters
Miles	1609	Meters
Square Feet	0.0929	Square meters
Square Miles	2.59	Square kilometers
Pounds	453.6	Grams
Pounds	$453.6/10^4$	Tons (metric)
Tons (metric)	1.103	Tons (short)
Tons (short)	907.2	Kilograms
Tons (short)	.9072	Tons (metric)
<u>To Obtain</u>	<u>By</u>	<u>Divide</u>